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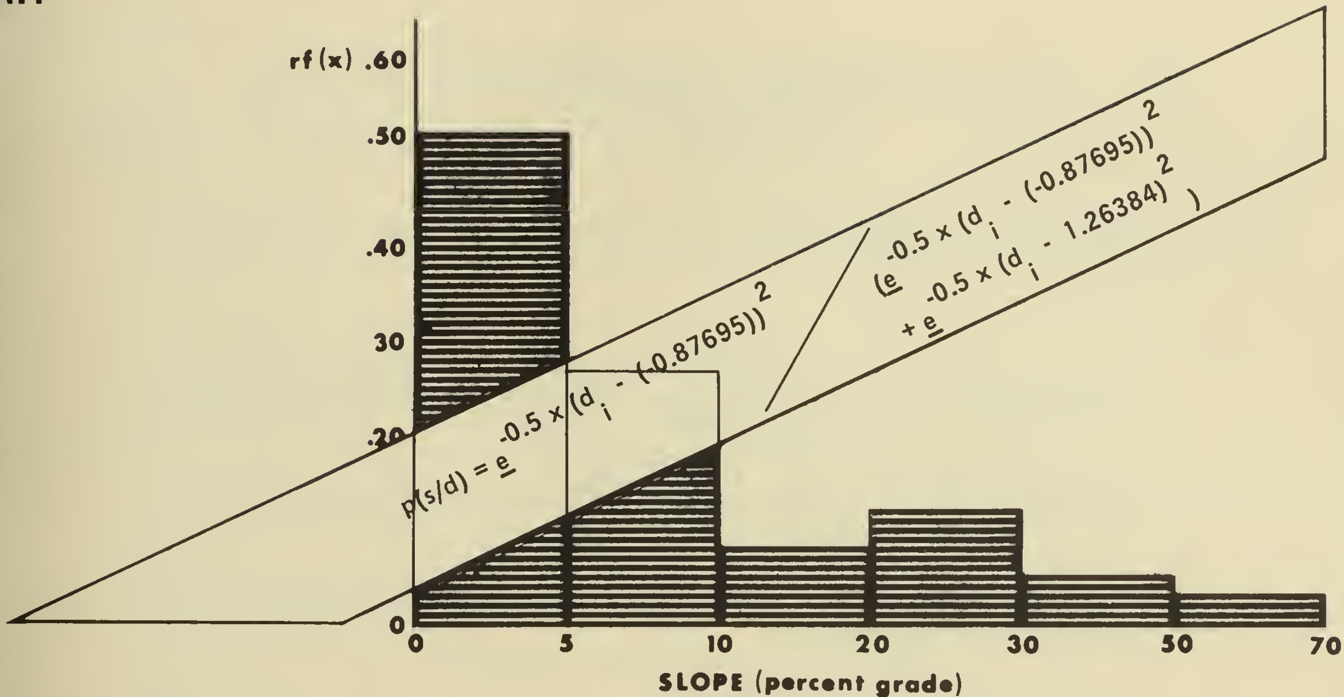

ARCHAEOLOGICAL INVENTORY IN THE SEEP RIDGE CULTURAL STUDY TRACT, UINTAH COUNTY, NORTHEASTERN UTAH

WITH

A REGIONAL PREDICTIVE MODEL FOR SITE LOCATION

1980

By
Signa L. Larralde and Susan M. Chandler

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A REGIONAL PREDICTIVE MODEL
FOR SITE LOCATION

By
Signa L. Larralde and Susan M. Chandler

Under the Direction of

Paul R. Nickens, Ph.D.

Nickens and Associates

Montrose, Colorado 81402

Prepared for the
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May 1981

"Archaeological Inventory in the Seep Ridge Cultural Study Tract, Uintah County, Northeastern Utah", represents the 11th volume in Utah's series of Cultural Resource Monographs. This regional study includes inventory and predictive modeling strategies and details the methodology to be used in making statements as to the presence or absence of archaeological sites. This publication is designed to share with the public and archaeological community the most current information collected by the Bureau of Land Management.

It is hoped that such publications will be of interest and value to others, others who share our concern to protect the wide array of cultural values on the public lands.

I am pleased to present this volume in the Utah series of Cultural Resource Monographs.

Lloyd H. Ferguson
Vernal District Manager
Bureau of Land Management

EDITOR'S NOTE

The Class II cultural resources inventory of the Seep Ridge Study Tract is another of a series of sample-oriented surveys designed to identify zones of cultural resource sensitivity in areas of intensive oil and gas development throughout eastern Utah. The results of the Seep Ridge study include a ten-percent coverage of the 109,400-acre tract, identification of the range and types of cultural resources located therein, and the delineation of sensitivity zones based on these data. Importantly, however, the Seep Ridge effort goes beyond the intuitive level of defining archaeological site distribution and provides a statistically-derived model for predicting site location on a regional basis. This analysis, based on a similar study in west-central Colorado, identified eight key microenvironmental and topographic variables which correctly accounted for about 90 percent of the sites in the regional analysis and about 97 percent of the Seep Ridge sites. This model provides a breakthrough in the prediction of site location in northeastern Utah and should be adaptable in other areas as a management tool for the protection and conservation of cultural resources on public lands.

Certain appendices from the original report have been omitted from the present volume, namely those which contain specific archaeological and paleontological site locational data. These include Appendices one through three, five, and eleven. Appendix twelve is added to provide a summation of the model, its equation and applications. Qualified researchers with a need to review these data can find these documents at either the Bureau of Land Management Vernal District or Utah State office.

Richard E. Fike
Paul R. Nickens

PREFACE

This report has been prepared in partial fulfillment of Bureau of Land Management Contract YA-553-CTO-1008. It contains results of a Class II survey of 10% of lands in the 109,400-acre Seep Ridge Study Tract, located in southeastern Uintah County, Utah in the BLM Vernal District.

The Seep Ridge Study Tract is situated in an area of intensive oil and gas exploration activities. Some zones of the tract are characterized by an extremely low density of cultural resources. A major purpose of this inventory was to obtain an estimate of the nature and distribution of archaeological sites, allowing for the identification of such zones where cultural resource inspection on a project-by-project basis might not be necessary. To this end BLM cultural resource specialists selected 274 40-acre survey units, using an unstratified systematic random sampling scheme. These units were located and inspected by our field crews.

Seep Ridge Project sites did cluster in specific areas, and sensitivity zones reflecting density and nature of cultural resources were constructed using environmental variables.

Although this step addresses some major variables influencing site location, a refinement utilizing regional data was incorporated into the project. A predictive model based on discriminant analysis of numerous environmental factors thought to contribute to site location decisions was constructed, drawing from Kenneth Kvamme's work on a similar Class II inventory of the Glenwood Springs Resource Area in western Colorado. The model was tested with Seep Ridge data and with data from several large adjacent surveys. The end product was an equation which, using information from U.S.G.S. quad maps and from field observations, classified a high percentage of site and non-site locations accurately. With further refinement, the equation has the potential to become a powerful management tool, preferable to the broader concept of sensitivity zones in more precisely assessing site location probability. In addition to the predictive model, an Indian rice grass gathering study was completed as part of the Seep Ridge Project.

Paul R. Nickens, as Principal Investigator, was responsible for overall accomplishment of project goals. Signa Larralde field-directed the project, assisted by R. Thomas Euler and Terry L. Adams. The efforts of the field crews in assuring thorough ground coverage and efficient data collection are appreciated. Susan M. Chandler prepared the predictive model and discriminant analysis section of the report, and compiled site information for the broad area encompassed in her study. Results of this able effort are presented as Chapter 5 of this document. We would like to thank Kenneth Kvamme for sharing his insight on various aspects of this phase of the project.

In the office, the work of Janet Sprouse as typist/editor deserves special commendation. Illustrations by Susan O'Connell and Johanna Winship contribute a great deal to the report's appearance.

Finally, gratitude is due Nancy Coulam, then BLM Vernal District Archaeologist, who served as the Contracting Officer's Authorized Representative for this Class II contract during the fieldwork phase of the project. Ms. Coulam provided support and assistance to our crews on several occasions. Recognition is also extended to Richard Fike, BLM State Archaeologist, who acted as COAR for the remainder of the project.

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ABSTRACT

In 1980 Nickens and Associates personnel completed a Class II cultural resource inventory of 10% of lands in the Seep Ridge Study Tract, a 109,400-acre area located in the southeast portion of the Bureau of Land Management Vernal District, Uintah County, Utah. One goal of the contract was the definition of suspected extremely low site density areas for management purposes. Utilizing a non-stratified systematic random sampling scheme, BLM preselected 274 40-acre sample units to be inspected. During the field inventory, 40 sites and 106 isolated finds were recorded in sample units. Cultural resources in the tract range in age from Paleo-Indian to historic Euro-American times. In contrast to the research design, which hypothesized low site density with exploitation of faunal resources along the White River and exploitation of floral resources in the dune fields northwest of Bonanza, cultural resources clustered on a major juniper-covered ridge system that apparently offered a combination of resources. High, medium and low sensitivity zones reflecting gross environmental variables important to site location were constructed. Twenty-seven sites (79.4%) were located in the high zone, defined by presence of juniper, for a site density of 6.54 per square mile. Four sites (11.8%) were located in the medium zone, defined by presence of sand dunes without juniper. The site density of this zone is 1.52 per square mile. The low zone, with neither juniper nor dunes, accounts for 3 sites (8.8%) and has a site density of .68 per square mile.

Prehistoric site data were compiled from several large surveys adjacent to and within the Seep Ridge Tract, and discriminant analysis was applied in order to construct a regional predictive model for site location. The model takes into account specific microenvironmental and topographic features believed to be important in prehistoric site location decisions. Eight key variables were defined; the model built on the basis of these variables correctly identified 89.8% of the sites in the regional analysis and 97.1% of the 34 prehistoric Seep Ridge sites. Further refinement of the equation derived from this analysis is recommended. The equation appears to have the potential to be a powerful location-specific management tool, capable of accounting for site loci more precisely than sensitivity zones based on single environmental variables.

An Indian rice grass gathering study was also incorporated into the project. Several gathering methods were tried. Yield, time investment, and processing data were collected. Methods that worked best were those most similar to rice grass gathering and processing as described by Margaret Wheat's Paiute informants. Yield was projected to be approximately 600 kg per square kilometer of dunes.

CHAPTER 1

INTRODUCTION

In spring and summer of 1980, Nickens and Associates archaeologists completed a field inventory of a preselected 10% random sample of Bureau of Land Management lands immediately north of the White River in Uintah County, northeastern Utah (Figs. 1 and 2). The inventory was undertaken as part of BLM Contract Number YA-553-CT0-1008. The area of the project encompasses several oil and gas fields and has long been mined for gilsonite.

The Bureau is required by law to identify, evaluate and protect cultural resources under its jurisdiction. This mandate becomes increasingly important in areas of intensive oil and gas exploration where a variety of ground-disturbing activities such as construction of well pads, access roads, and pipelines is necessary for energy development. While mindful of its responsibilities to protect cultural resources, BLM is aware that previous surveys in and near the 109,440-acre Seep Ridge study tract have indicated that large portions of the tract are nearly devoid of archaeological sites. Many of the sites recorded to date tend to be relatively insignificant. These considerations lead to the premise that project-by-project cultural resource clearances may not be necessary for some portions of the tract characterized by extremely low site density.

The Seep Ridge cultural resource inventory was designed to respond to this situation in a number of ways. BLM outlined some specific objectives of the inventory in the scope of work, as follows:

> Recognition or elaboration of patterns of past human use and occupation.
>
> Determination of the cultural resource potential of the study areas.
>
> Prediction of zones of greater or lesser activity by past human populations.
>
> Identification and assessment of the environmental and/or cultural variables, or combination of variables, that form the most accurate predictors of cultural resource sites.
>
> Development of projections of expected density distribution and diversity of cultural resources.
>
> Discovery of the range of cultural resource variability within the study areas.

Since several other extensive surveys have been completed in the southeastern parts of Uintah County, the Seep Ridge inventory presents an opportunity for data synthesis.

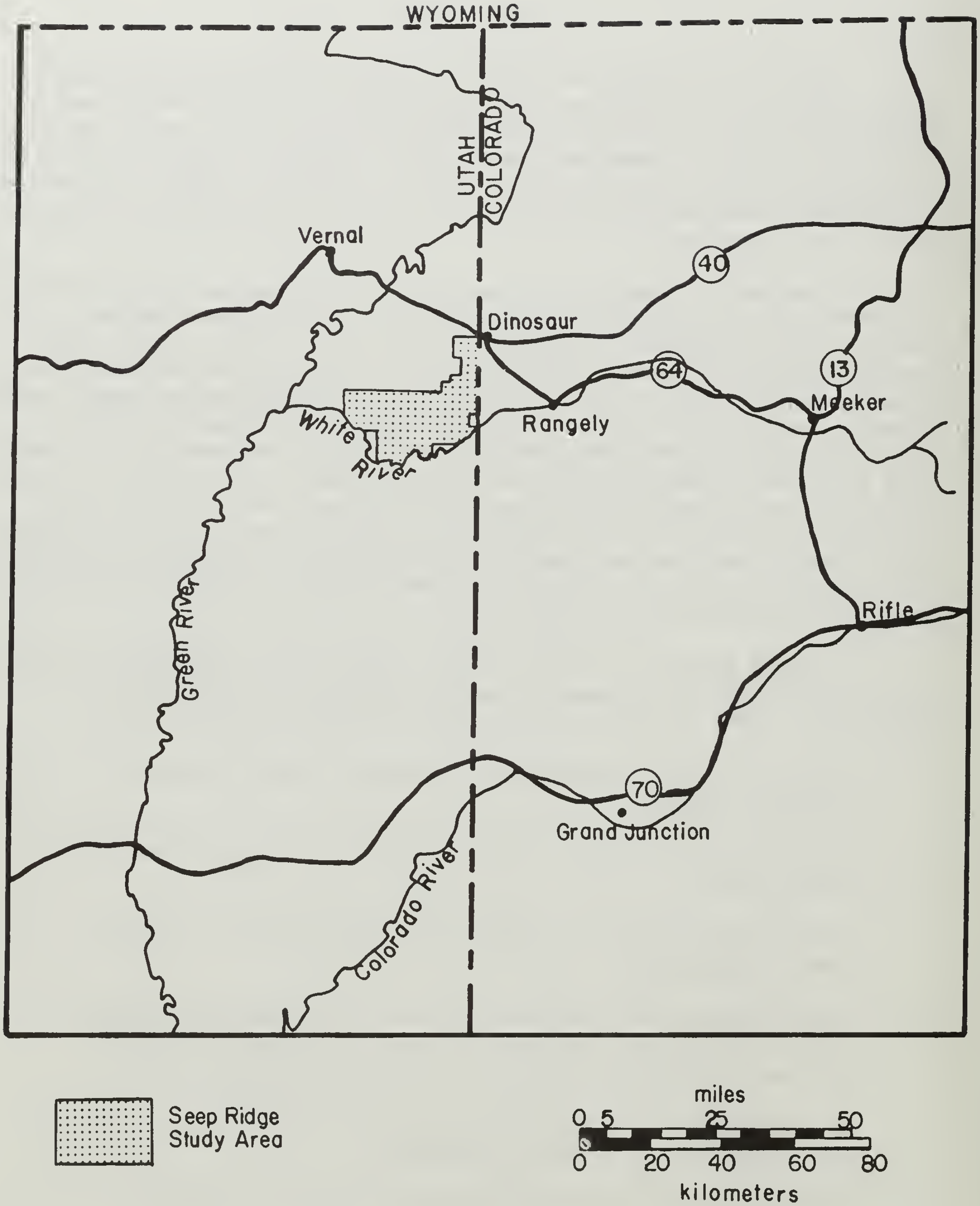


Figure 1. General area map showing location of Seep Ridge Cultural Resource Study Area.

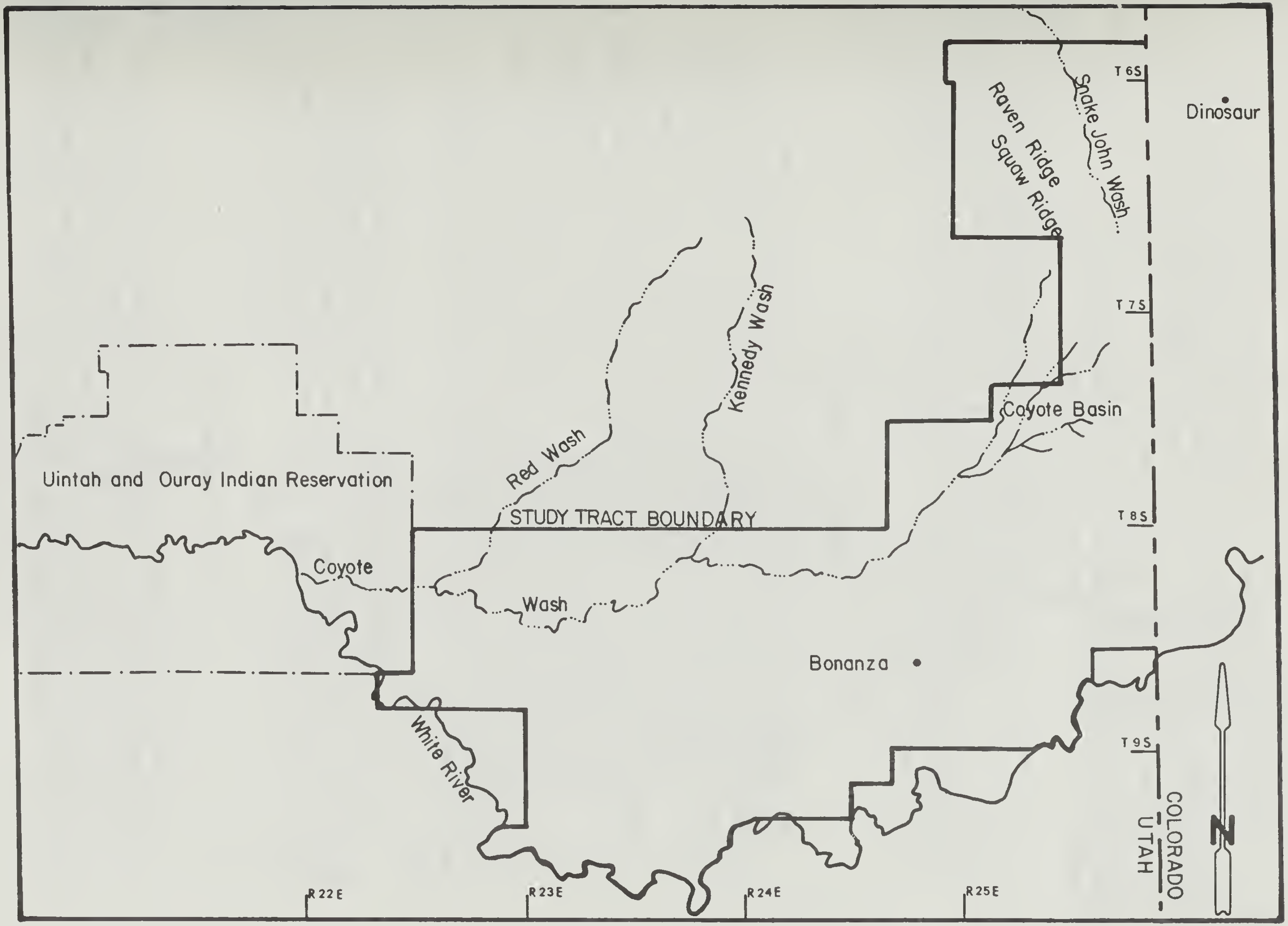


Figure 2. Area map showing Seep Ridge study tract boundary and local geographic features.

The following response to these objectives has two parts. The first is the intensive inventory itself, which entailed survey of 274 40-acre sample units in which 41 archaeological sites were recorded. Data from the inventory will be utilized in the following chapters to develop sensitivity zones and recommendations for future cultural resource clearances on lands in the Seep Ridge study tract. The sampling design and field methodology discussed in the remainder of this chapter refers to the Seep Ridge inventory.

The second part of this report is the construction of a regional predictive model based on data gathered from the Seep Ridge cultural inventory, from another similar BLM Class II (sample-oriented) inventory in an adjacent area (Red Wash), and from several other small inventory projects located inside or adjacent to the broad boundaries of these two large projects (Fig. 3).

Sampling Design

To accomplish the objectives discussed above, BLM devised a systematic random sample of 10% of the study tract, calling for intensive survey of 10,944 acres. Sample unit size, shape, and distribution were selected to match those of adjacent inventories. 274 40-acre units measuring one-half mile by one-eighth mile were chosen; these were situated in quarter sections so that cadastral monuments could be used to maximize location control. To paraphrase the scope of work, the selection process consisted of dividing the area into quarter sections numbered from 1 to 684 and choosing 274 quarter sections with a random numbers table. Each sample unit was systematically placed in its quarter section to extend from section corner to quarter corner. The distribution of sample units in the project area is illustrated in Figures 4, 5, 6, and 7. Two sample units had already been inspected in conjunction with the archaeological survey of a power plant site within the study tract (Chandler and Nickens 1979b). Replacements were selected in adjacent quarter sections.

The major difference between this sample and the Red Wash and Natural Buttes samples is that previous samples were proportionally stratified by drainage and vegetation zones whereas the Seep Ridge sample is random. Implications of this sampling strategy for survey results will be discussed in Chapter 6.

Survey Methodology

The sample was inventoried under the general direction of Dr. Paul Nickens, Principal Investigator, and under the field direction of Signa Larralde. Thomas Euler and Terry L. Adams were crew leaders for portions of the project. The field crew consisted, at various times, of Margaret Adams, Deborah Caskey, George Gerstle, Jeffrey Jennings, Kim Kreutzer, Robert Kriebel, Barbara Roth, Igor Steel, and Pauline Wilber.

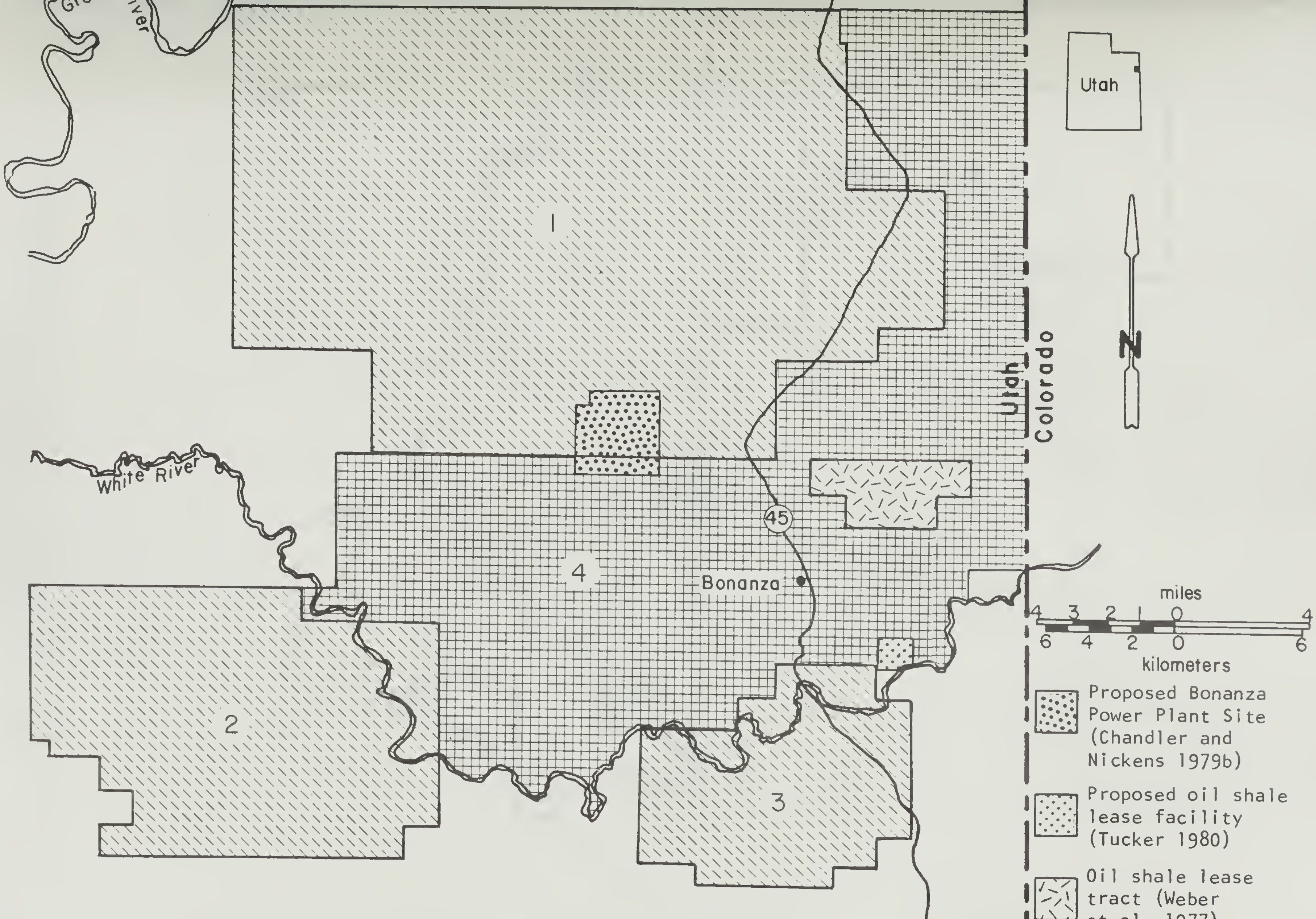


Figure 3. Seep Ridge Cultural Study Tract (4) and surrounding large-scale cultural resource inventories: (1) Red Wash Study Tract (Larralde and Nickens 1980); (2) Natural Buttes Study Tract (Hauck et al. 1979); (3) Oil Shale Lease Tracts (Berry and Berry 1976).

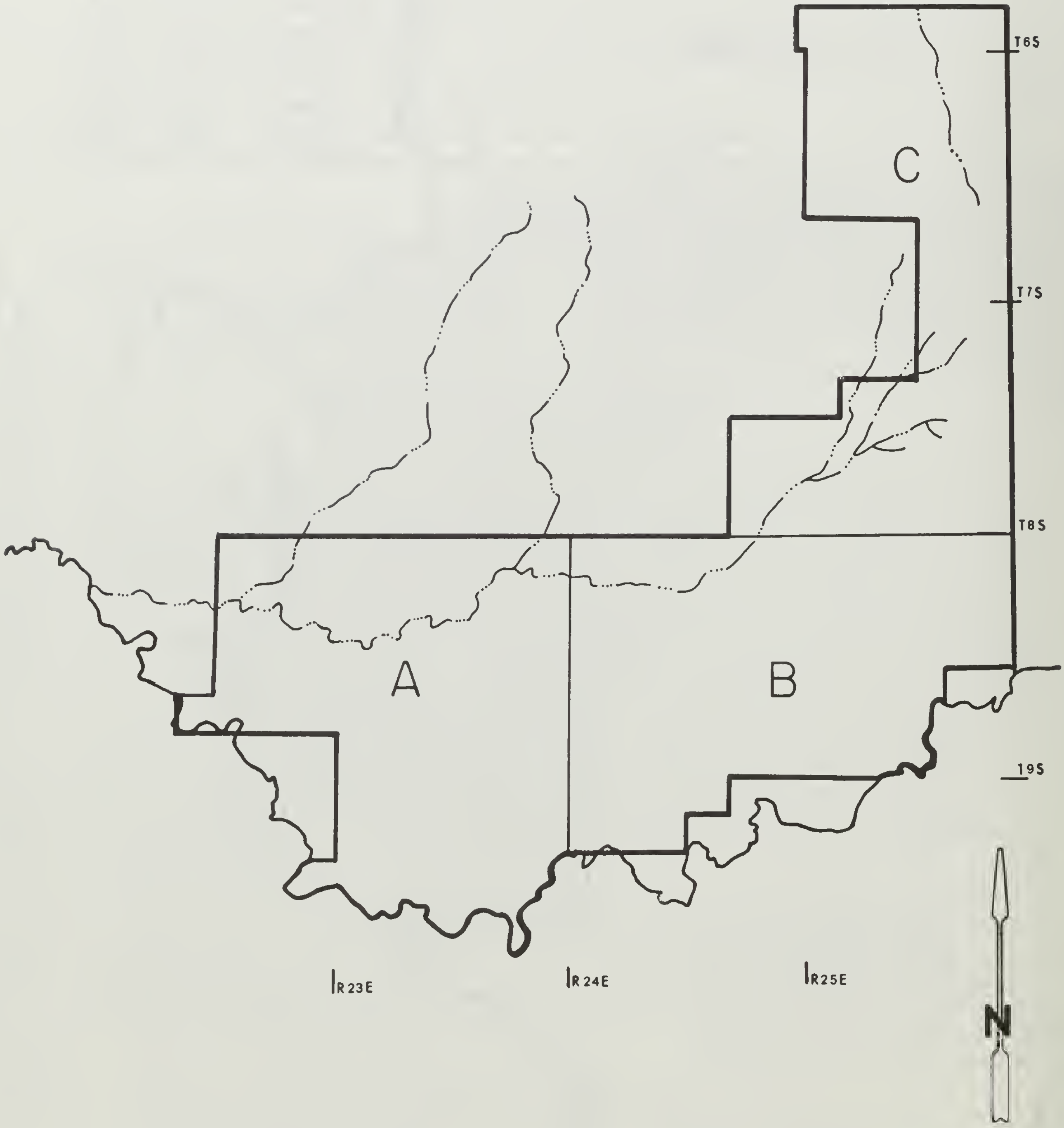


Figure 4. Map key of project area showing division into three parts for reference to following maps.

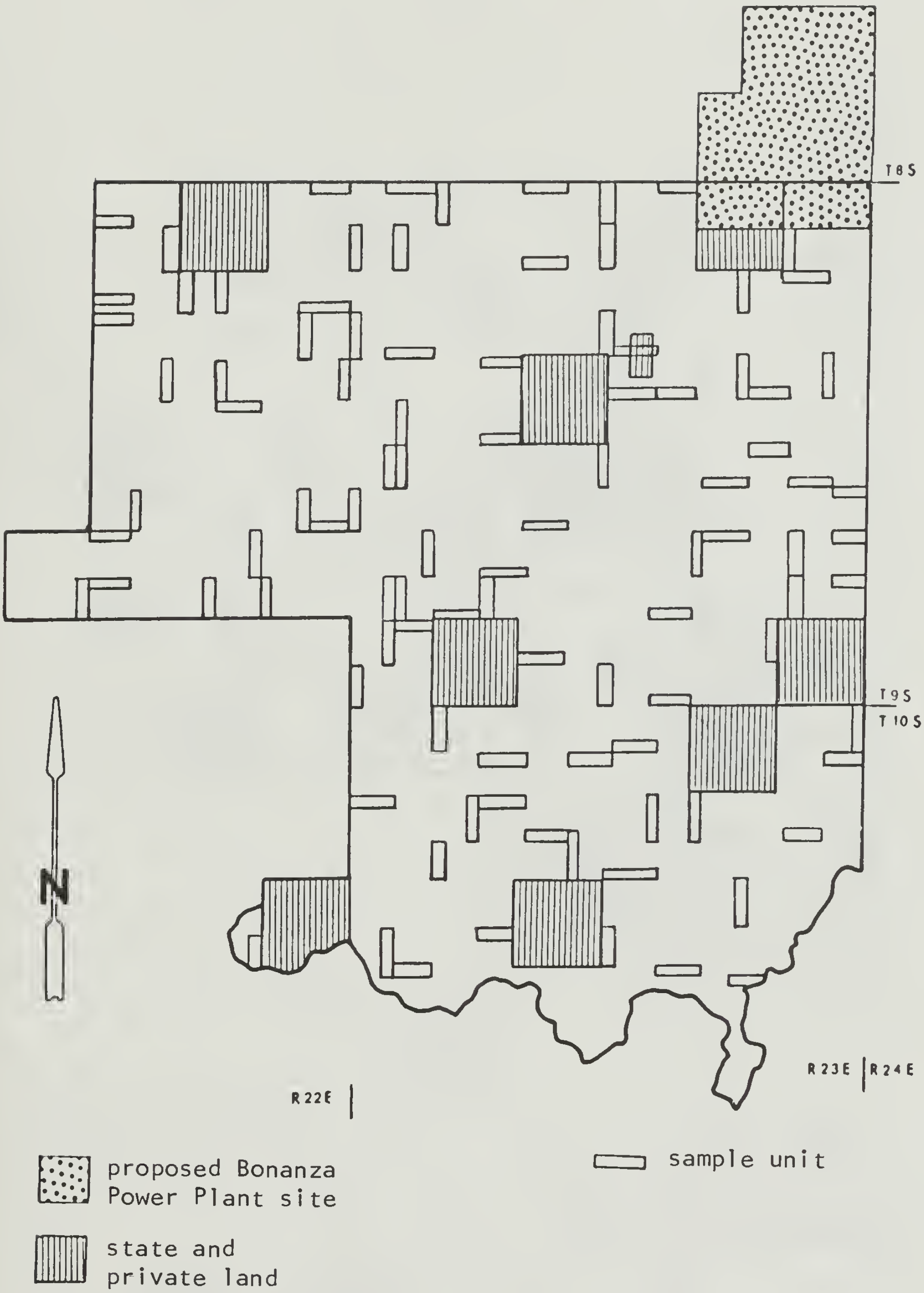


Figure 5. Distribution of randomly selected 40-acre sample units in part A, the west third of the project area.

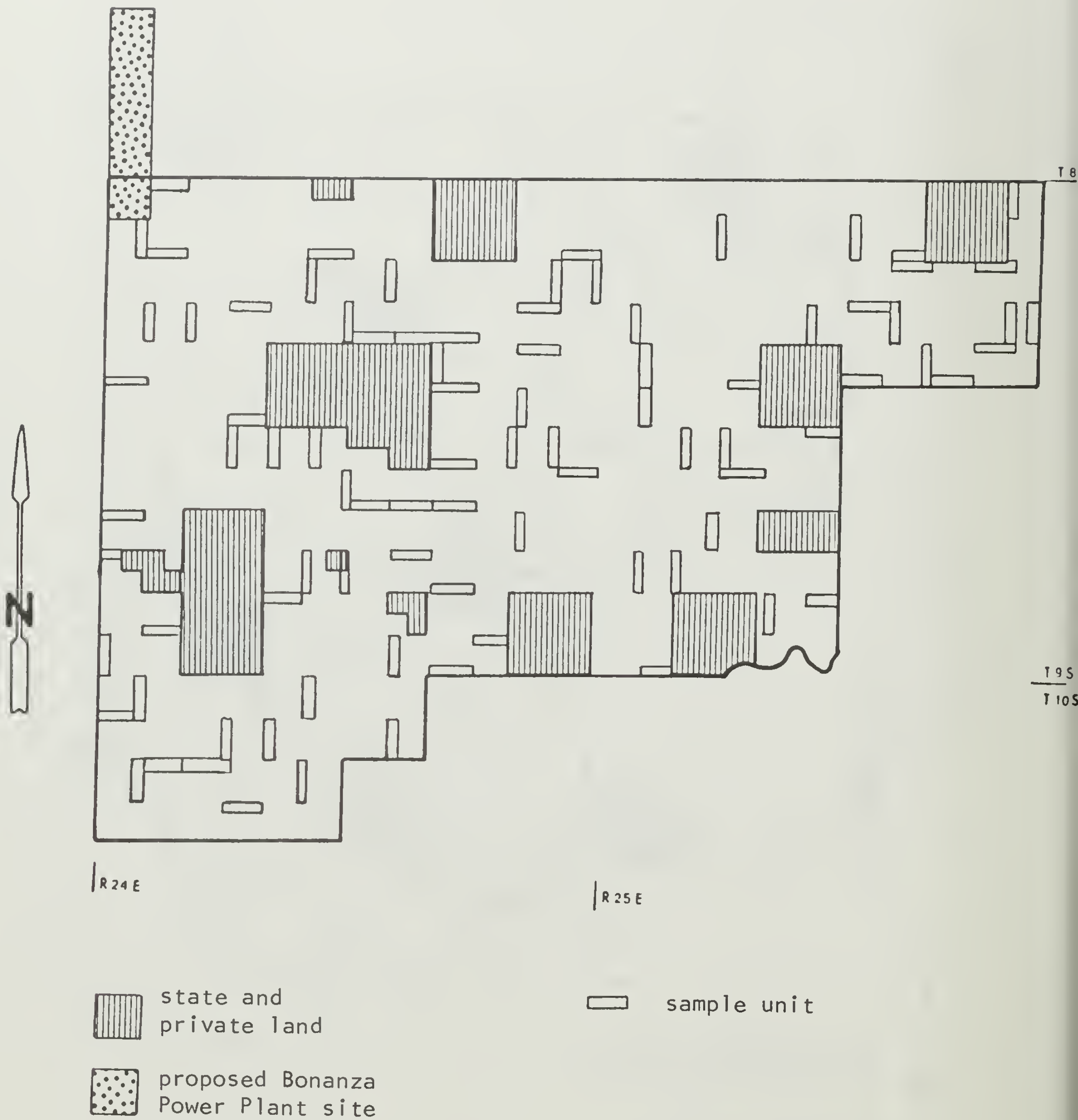


Figure 6. Distribution of randomly selected 40-acre sample units in part B, the central third of the project area.

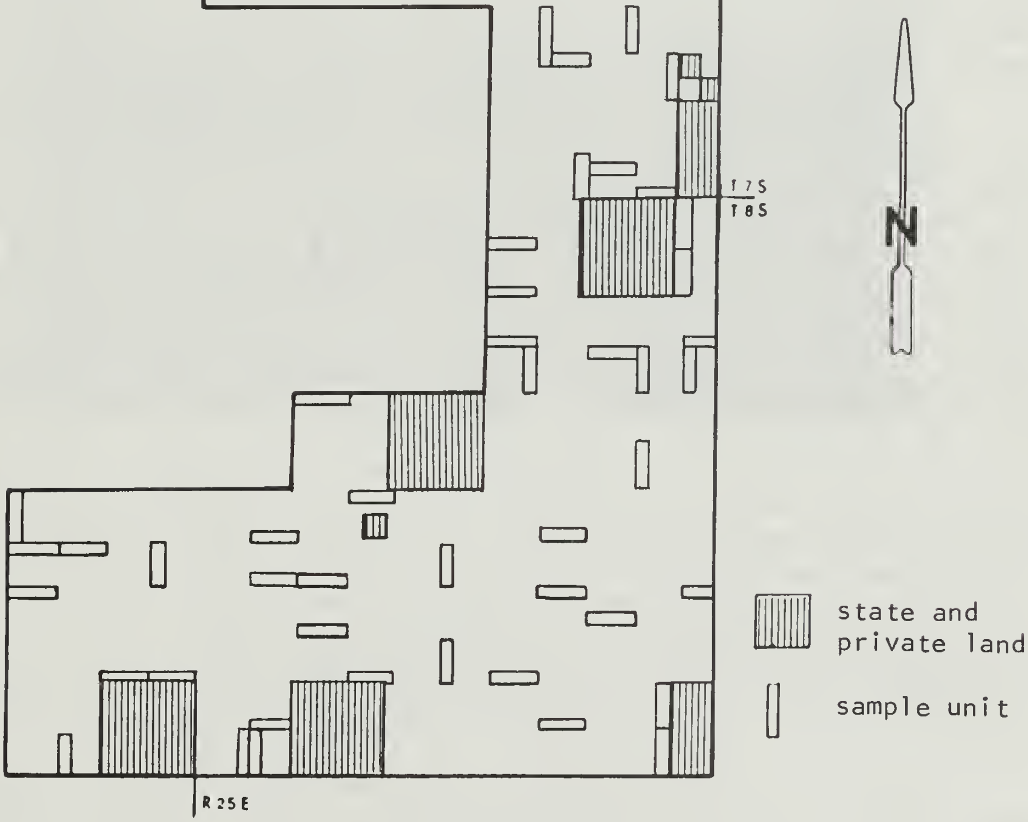


Figure 7. Distribution of randomly selected 40-acre sample units in part C, the northeastern third of the project area.

Fieldwork was conducted from May 6 through July 21, 1980, a total of 306 person-days. Due to an exceptionally wet and stormy spring, four days were lost to inclement weather. The crew was housed in two trailers in Dinosaur, Colorado, three miles from the nearest sample unit and approximately 40 miles from the farthest.

The 274 sample units were inventoried by crews ranging in size from three to six persons. After location of the cadastral marker, the crew walked across the unit in adjacent parallel sweeps with crew members spaced no more than 15 meters apart. Figure 8 illustrates this survey method, which was very well suited to most of the terrain in the project area. The number of sweeps required to cover the unit at the above spacing interval varied by crew size from four to two. Sweep direction was maintained by means of orientation with 7.5' topographic map and compass. In order to maximize thorough coverage, surveyor's flagging was used to mark the inside line and the beginning and ending points of the sweep. Flagging was retrieved on the return sweep. Distance was paced or measured using natural features.

On the occasions that cadastral markers were not found, sample units were confidently located by means of orientation to prominent natural features or cultural features such as surveyed-in drill casings marked on topographic maps.

When sample unit terrain consisted of a series of deep drainages and high ridges or other similar formidable barriers, one of two strategies was employed. Either the day's work was planned in advance so that a large crew could cover the unit in two sweeps, or the crew would divide into smaller teams, each intensively inspecting a topographically defined part of the unit such as ridge tops, drainage bottoms, or narrow terraces. Aside from practically and safely solving the problem of covering rugged terrain, this strategy probably results in a more thorough cultural inspection. Spacing between crew members varied under these circumstances, but coverage was thorough and continuity between sweeps was maintained.

Since environmental data were not incorporated into the sampling design, it was especially important that sufficient information be collected for later analysis of site types and locations in relationship to environmental variables. To provide for this need, a sample unit record form (Appendix 1) was completed for each unit surveyed. The form was designed specifically to include information about vegetation and about sand dunes and rock outcroppings, shown by previous surveys to be favored for archaeological site locations. The sample unit records also provide information about kinds of locales where sites do not occur.

When cultural material was encountered, the crew leader determined whether a site designation or an isolated find designation was appropriate, or whether the material would be described in the fieldbook but not recorded as a site. Recent corrals, trash, and campsites fall into the latter category. Summaries of recorded sites and isolated finds can be found in Appendices 2 and 3. Site and isolated find locations were plotted on the appropriate topographic maps. Sites were recorded on BLM

Figure 8. The survey crew is lined up and ready to start a sweep. This terrain is typical of the large basin around Snake John Wash at the far north end of the project area. Grasses dominate, with isolated greasewood and other shrubs also present. Snake John Reef is the low barrier in the distance, with Blue Mountain on the horizon.

Form UT8100-1; features and site boundaries were mapped and artifacts were analyzed in situ to determine site function, cultural affiliation, and chronological placement. Most stone tools and isolated prehistoric artifacts were drawn. Collection of artifacts was limited to diagnostic projectile points, ceramics, obsidian, and some diagnostic historic artifacts. Certain other artifacts considered likely to be picked up by nonprofessionals were also collected. A catalog of collected artifacts is presented as Appendix 4. These items will eventually be curated at Dinosaur Natural History Museum in Vernal.

Environmental data recorded at each site included topographic disposition, a list of vegetation present on and near the site, and nearest water source. Fossil locales (Appendix 5), whether isolated fragments or fossil scatters, were marked on the appropriate topographic map and described in the fieldbook. Environmental data for these locales were also recorded.

CHAPTER 2

ENVIRONMENT

Location

The 109,440 acre project area is situated in east-central Uintah County, Utah, in the Bonanza Planning Unit of BLM's Vernal District. As shown in Figure 2, it is bounded on the east by the Colorado-Utah state line, on the south by the White River, on the west by the Uintah-Ouray Ute Indian Reservation and the Red Wash Project Area (Larralde and Nickens 1980) and on the north by an arbitrary line one mile north of Township 7 South. The two major thoroughfares through the project are Utah State Highway 45, which links Bonanza with U.S. Highway 40 to the north, and a partially paved road crossing the area from east to west, starting at Colorado State Highway 64 and proceeding through Bonanza and on to the town of Ouray on the Ute Indian Reservation. A network of secondary gravel and unimproved roads provides access to all parts of the project area.

Geomorphology

The project area lies at the southeastern edge of the Uintah Basin, a distinct bowl-shaped division of the large Colorado Plateau physiographic region (Stokes 1977). The basin is surrounded by the Wasatch Mountains, Uintah Mountains and Tavaputs Plateau respectively to the east, north and south, and extends into northwestern Colorado to the east. Geology of the basin is characterized by "young" tertiary-age formations overlying Cretaceous formations. These surfaces were deposited by a series of lakes and slow streams. Conversely, water erosion of the resulting depositional benches has been the major force in forming the present landscape (Marsell 1964:32).

Clark divides the Uintah Basin itself into six geomorphological districts. Most of the Seep Ridge Project area lies in the Central Badlands District, but portions of the Northeastern Area and the Tavaputs Plateau are also included. The Central Badlands are predominantly underlain by the mudstones, claystones and bentonitic clays of the Uintah formation, interspersed with thin layers of siltstones and sandstones (Marsell 1964:36). Some portions of the Seep Ridge Project area lie on the broad erosional benches and badlands rims so characteristic of the Red Wash Project area. Figure 9 illustrates these barren clay ridges. But, for the most part, the Seep Ridge Project area can be conceived of as a series of smaller basins draining to the north and west, Coyote Basin being the largest. Eroded buttes characterize the landscape (Fig. 10). Steep shaley canyons cut by intermittent tributary drainages to the White River form the south periphery (Fig. 11). Raven and Squaw Ridges (Fig. 12), parallel hogback "reefs" or anticlinal folds similar to many in the Uintah fault system, are an important geologic feature trending from northeast to southwest through the northeast corner of the project. The ridges are composed of Mesa Verde sandstone capped by the Wasatch Formation and are bordered by low rolling hills on the west.

Figure 9. Barren clay badlands characteristic of some parts of the central and western project area.

Figure 10. Eroded buttes in the southwestern project area. This scene typifies much of the Seep Ridge landscape. A sparse desert shrub vegetation community is typical.

Figure 11. Steep shaley canyons formed by intermittent tributary drainages to the White River are found in the south periphery of the project.

Figure 12. Looking south down the crest of Squaw Ridge toward the Utah-Colorado state line. Raven Ridge is an identical anticlinal fold at the far left. Most of the juniper within the project boundary grows in proximity to these ridges.

Clark (1957:18) mentions two characteristics of the Badlands division related to stream and wind erosion of benches and badlands that are of interest in the study of area prehistory: 1) presence on the benches of a cap of sand or silt 10 to 100' thick, which has formed dunes of varying activity in some areas; and 2) "desert pavement" locales covered by chert cobbles suitable for tool manufacture. Water erosion exposes the sandy stream banks and beds, and floods bring in sand from eroded sedimentary formations. Wind erosion scours the landscape, resulting in denuded pavements and the build-up of dunes (Butzer 1971).

"Free" dunes, existing independently of topography, and "tied" dunes, related to a permanent wind obstruction, are both present in the project area. Tied dunes are found in and on ridge systems, especially along the northeast face of Raven Ridge. They appear as the light zone along the ridge in Figure 13. The dune in Figure 14 is "tied" to the badlands ridges in which it formed. Lee dunes are the most conspicuous form of tied dunes and often grow into longitudinal shapes (Butzer 1971: 196).

"Free" dunes are dependent on wind patterns rather than on an obstacle for their shape. These dunes also can take longitudinal form, which seems to be the case in the barren low-elevation badlands basin floodplains of the Seep Ridge Study Tract (Fig. 15). Here, the wind has created dune fields of varying degrees of activity from the sandy eroded beds of the large washes and from the cap of sand and silt on the benches above. Dunes flank the major unentrenched washes in the project area. Other free dune forms include crescentic or barchan dunes, transverse dunes growing at right angles to wind direction, and parabolic dunes, all of which are uncommon in the study tract.

Although often complex and still not well understood, the history of prevailing winds and of effective winds can be deduced from the morphological variables and from the grain-size sedimentation of dunes. Prevailing winds affect dune position in relation to sand source area; effective winds such as gales and storms determine dune orientation and bedding directions. The Uintah Basin is characterized by relatively light prevailing winds from the south and southwest and storm winds from the west and northwest, varying on local topography (Ken Hubbard, Assistant Utah State Climatologist, personal communication). These winds are responsible for the placement of dunes in the study tract, and as wind direction suggests, the dunes are oriented to the east and northeast in relation to sand sources.

Dunes occur in semi-arid areas with little vegetation, yet vegetation affects the development and behavior of dunes, and dunes provide a more hospitable environment for plants. The water-conserving properties of sand have long been recognized (cf. Sharp 1966:1047). Many plants, including the grasses _Oryzopsis_ and _Hilaria_, have evolved root systems suited to utilization of sub-surface moisture under conditions of active sand deposition. Although vegetation composition varies among the major dune areas in the study tract, an easily recognized relatively lush "dune association" is typical and ubiquitous. This association is discussed in the vegetation section below.

Figure 13. Raven Ridge viewed to the southwest. The light juniper-covered areas at the base of the ridge are "tied" dunes, i.e. tied to the ridge as a permanent wind obstruction.

Figure 14. Active dune in west project area. This dune is "tied" to the surrounding barren ridges, the obstacle around which it formed. Dark areas in the distance are the "free" dune fields of the Red Wash floodplain.

Figure 15. "Free" dune near proposed Bonanza Power Plant site. This dune is part of a large dune field and served as an *Oryzopsis* study area. A prehistoric campsite is located in a blowout behind the dune crest.

The factors of distinctive plant association, frequent location near large intermittent drainages which offer other resources, possible shelter potential on the lee side of dunes and in blow-outs, and availability of raw lithic materials in nearby desert pavement areas all add to the attraction of dunes as site locations for hunter-gatherers. Alluvial quartzitic sandstone cobbles for grinding stones are usually present.

Shelter potential in the remainder of the project area is limited to occasional sandstone bluffs in the south and west (Fig. 16) and the windbreak and shallow sandstone shelters the large ridge system provides in the northeast. An additional lithic raw material common on local archaeological sites is oolitic chert, which outcrops on Raven Ridge.

Soils

Wilson et al. (1968:7) characterize soils in the central part of the basin as having thick lime horizons in the subsoil with a dense lime hardpan in some areas. In general, these soils are classified as warm, usually dry, and dominantly deep, primarily torriothents and torrifluvents (Upper Colorado Region Comprehensive Framework Study 1971). The effective depth is 20 to 60 inches, with loamy or clayey, well-drained and moderately permeable textural profiles. Deep soils are present on stream terraces and alluvial fans. These arable "pockets" are intermixed with areas of poorly drained salt and alkali-affected soils and are surrounded by barren lands, bluffs and shale hills (Wilson et al. 1968:26-27).

Water Resources

Major intermittent streams that drain the project area are Coyote Wash (Fig. 17) and its large tributary Red Wash, which flow into the White River; Powder Springs Wash and Snake John Wash, flowing eventually to Cliff Creek, a Green River tributary; and Dripping Rock Creek, a major White River tributary that lies outside the project area to the east. These drainages lack the rugged, convoluted nature of the Red Wash project drainages because the erosional bench is no longer present over most of the Seep Ridge tract. Aside from several observed seeps and springs of unknown permanence, the White River is the major permanent water source but steep terrain and a vertical drop of several hundred meters make access difficult along most of its course in this area. The Green River is equidistant to the White from the north end of the study tract.

Climate

A semiarid climate prevails in the Uintah Basin. Annual precipitation in the Seep Ridge area ranges from 16 inches in some parts of the east end (Berry 1968) to 8 inches in the west. Nearest weather stations are at Jensen, Vernal (Brown 1960) and Rangely (U.S. Dept. of Commerce 1964), bracketing the study tract. Average annual temperature, precipitation, and growing season for these stations are presented in Table 1, along with elevation.

Figure 16. Rock outcroppings provide shelter potential in the southwest parts of the project area. The crew records a site which extends around the east edge of this bluff. Arrow points south.

Figure 17. Coyote Wash as it cuts through a small canyon in the west project area. This wash and other broad washes drain west to the White River. Floodplain vegetation consisting of greasewood, clumps of tamarisk and isolated cottonwood trees occurs in and around these washes.

Table 1. Climatic and elevation data for weather stations surrounding the Seep Ridge Study Tract.

	Jensen	Vernal	Rangely	Seep Ridge tract
Average annual precipitation	8.22"	7.88"	8.76"	ca. 8 - 16"
Average annual temperature	45.4	44.3	46.8	---
Growing season	118 days	124 days	---	---
Elevation	4779'	5280'	5220'	4700' - 6409'

Wilson et al. (1968:26) note that rainfall is very low, averaging from 6 to 10" yearly over most of the central Uintah Basin, with a mean frost-free period of 110 to 130 days. Arable land can be dry farmed with 10 to 20" of rain per year (Wilson et al. 1968:9); parts of the project area, then, are very marginally suitable for agriculture.

Storms blow in both from the west along the Wasatch Range and from the northwest along the Uintah Mountains. A seasonal variability in storm patterns appears to be in effect. Although precipitation is well-distributed, most rainfall occurs during spring and early fall months, with erratic summer thunderstorms and typically extreme dry summers and winters (Holmer 1979:9).

Although change in environmental conditions over time is important in understanding occupation of this desert, paleoenvironmental studies for the Uintah Basin remain to be done. Madsen and Currey (1979) have analyzed pollen and geology on the west slope of the central Wasatch Range, and Reed and Nickens (1980) have documented past environments in a rock shelter in DeBeque Canyon, western Colorado. Results of these two studies are briefly summarized in Table 2. Evidence from both studies aligns with general climatic trends suggested by other studies for the Rocky Mountain region. Although the data have general bearing for northeastern Utah, specific effects on the Seep Ridge area are unknown. Small climatic fluctuations are probable, but indications are that the environment and biota in the study tract have remained substantially the same over the past 10,000 years.

Vegetation

Aside from their importance in formulating relatively recent subsistence patterns, studies of present vegetation provide data for the reconstruction of paleoenvironment. In the Seep Ridge project, field observation vegetation maps were drawn of each sample unit inventoried. This information was checked against infra-red aerial photos. However, small

Table 2. Summary of paleoenvironmental information from studies east and west of the Seep Ridge Tract.

Years B.P.	Central Wasatch Range* temperature/precipitation	DeBeque Rockshelter** temperature/precipitation
1000	cooler/drier	
2000		
3000	warmer/wetter	warmer
4000	cooler/wetter	
5000	wetter	cooler/wetter
6000	warmer	warmer/drier
7000	drier	
8000		
9000		
10,000	cooler/drier	
11,000		
12,000		

*Madsen and Curry 1979. Comparison to Holocene average.

**Reed and Nickens 1980. Based on pollen and mollusc studies.

scale and poor quality of available aerial photographs precluded constructing a vegetation map of the project area. Fortunately, additional data are available from detailed vegetation studies of the proposed Bonanza Power Plant site and connecting coal and water transport corridors (Allan 1979, 1980), all of which encompass parts of the Seep Ridge Study Tract. This information is useful not only in delineating plant communities and associations but in assessing impacts of grazing and other ground disturbance on the past vegetative environment.

Plant communities reflect the broad influences of altitude, moisture and soil gradients (Allan 1979:9), while associations are sensitive to finer variations. The vegetative situation in the project area is characterized by an overlap or blending in communities and in associations, indicative of broad ecotonal bands especially between sagebrush and desert shrub zones. The following plant communities were observed:

Juniper

The juniper community occurs in three well-defined areas: Raven and Squaw Ridges and their foothills, the dunes surrounding Snake John Wash and its major tributaries, and the area of low ridges and hills above the steep White River tributary canyons. The community is dominated by Utah juniper (Juniperus osteosperma utahensis). Understory plants vary by elevation, but include Utah serviceberry (Amelanchier utahensis), mountain mahogany (Cercocarpus intricatus), ephedra (Ephedraceae sp.), prickly pear cacti (Opuntia sp.), and sparse grasses. Absence of pinyon pine indicates a more xerophytic environment at lower elevations (Welsh 1957:42). Allan (1980:98) describes a "mountain brush" association on the shaley, rocky west slope of the two high ridges, which alternates with bands of juniper and shadscale. Here, mountain mahogany (Cercocarpus montanum) dominates, along with blackbrush (Coleogyne ramosissima) and shadscale. Horsebrush and snakeweed are subdominants. Figures 12 and 18 are representative of this zone as it occurs in the project area. Table 3 summarizes dominant species in this and other communities described below.

Sagebrush

This zone takes in virtually all the east project area not included in the juniper zone. As noted above, the sagebrush-saltbush ecotone is poorly defined and make-up of the ecotonal communities varies over the central and west portions of the project area. Big sagebrush (Artemesia tridentata) cover is uniform and dense in the east project area, as shown in Figure 19. An understory of grasses and forbs is present although sparse. Other shrubs such as four-wing saltbush, rabbitbrush, spiny hopsage and horsebrush occur infrequently. Some portions of the southern project area are also sagebrush-dominated (Allan 1979:78).

Saltbush

The saltbush or desert shrub community varies considerably in member plants and is distinguished from the sage community by dominance

Table 3. Summary of dominant plant species* in communities represented in the Seep Ridge Cultural Study Tract.

Scientific Name	Common Name	C x F[1] Rel. Abundance	Avg. % Total Cover
SAND DUNE ASSOCIATION (4 stands sampled)			
Shrubs			15.8
Chrysothamnus viscidiflorus var. *puberulus*	sticky-flowered rabbitbrush	122.6	
Atriplex canescens	4-wing saltbush	38.3	
Chrysothamnus nauseosus	golden rabbitbrush	19.4	
Crayia spinosa	spiny hopsage	19.8	
Grasses			17.5
Oryzopsis hymenoides	Indian rice grass	976.1	
Perennial Forbs			4.1
Astragalus chamaeleuce	loco weed or	6.3	
Astragalus convallarius	milk vetch	15.1	
Physaria acutifolia	twinpod	13.8	
Annuals			13.3
Salsola kali	Russian thistle	250.0	
Gilia leptomeria	Great Basin gilia	134.1	
Mentzelia albicaulis	white-stem blazing star	141.1	
Nama demissum	purple mat	19.0	
Bromus tectorum	cheat grass	33.1	
Total % Living Cover			50.7
Average No. Vascular Species		27.0	

*Data compiled by Allan (1979:23-27, 52) for the proposed Bonanza Power Plant site, which encompasses part of the Seep Ridge Project area. The juniper association data were gathered near the town of Red Wash.

[1]C = cover, F = frequency, which when multiplied together gives a relative abundance index varying between 0 and 10,000.

Table 3, continued

Scientific Name	Common Name	C x F Rel. Abundance	Avg. % Total Cover
SALTBUSH-BUDSAGE (4 stands sampled)			
Shrubs			19.6
Artemisia spinescens	bud sagebrush	408.0	
Atriplex cuneata	short saltbush	623.8	
Grasses			1.8
Oryzopsis hymenoides	Indian rice grass	21.8	
Perennial Forbs			4.0
Astragalus chamaeleuce	milk vetch or loco weed	5.9	
Erigeron pumila	fleabane	16.5	
Sphaeralcea coccinia	scarlet globemallow	37.4	
Annuals			43.8
Bromus tectorum	cheat grass	1131.5	
Cleome lutea	yellow bee plant	175.5	
Gilia pumila	gilia	51.2	
Halogeton glomerata	halogeton	134.4	
Lepidium densiflorum	peppergrass	11.2	
Malcolmia africana	African mustard	1072.4	
Plantago purshii	Indian wheat	531.0	
Salsola kali	Russian thistle	17.6	
Cryptogams			2.5
Lichens		143.7	
Total % Living Cover			71.7
Average No. Vascular Species		20.5	

Table 3, continued

Scientific Name	Common Name	C x F Rel. Abundance	Avg. % Total Cover
GREASEWOOD (2 stands sampled)			
Shrubs			24.4
Artemisia tridentata	big sagebrush	1073.0	
Sarcobatus vermiculatus	greasewood	32.3	
Grasses			4.9
Hilaria jamesii	Galleta grass	104.3	
Perennial Forbs			8.0
Lepidium montanum	peppergrass	11.1	
Annuals			10.6
Bromus tectorum	cheat grass	49.6	
Camasonia pterosperma		51.8	
Cleome lutea	yellow bee plant	37.5	
Gilia leptomeria	Great Basin gilia	149.6	
Malcolmia africana	African mustard	174.3	
Cryptogams			8.46
Lichens		149.5	
Moss		259.8	
Total % Living Cover			56.4
Average No. Vascular Species		27.0	

Table 3, continued

Scientific Name	Common Name	C x F Rel. Abundance	Avg. % Total Cover
GRASSLANDS (2 stands sampled)			
Shrubs			17.1
Atriplex canescens	4-wing saltbush	5.6	
Grasses			29.3
Hilaria jamesii	Galleta grass	1562.3	
Oryzopsis hymenoides	Indian rice grass	9.4	
Stipa comata	needle and thread grass	364.0	
Perennial Forbs			6.5
Astragalus chamaeleuce	loco weed or milk vetch	35.5	
Opuntia polyacantha	prickly pear	54.4	
Sphaeralcea coccinea	scarlet globemallow	21.4	
Annuals			28.7
Bromus tectorum	cheat grass	919.8	
Cryptantha crassisepala	cryptantha	43.8	
Festuca octoflora	six-weeks fescue	59.0	
Gilia leptomeria	Great Basin gilia	29.5	
Gilia pumila	gilia	129.8	
Lappula occidentalis	stickseed	17.6	
Lepidium densiflorum	peppergrass	30.6	
Mentzelia albicaulis	white-stem blazing star	160.0	
Plantago purshii	Indian wheat	99.8	
Cryptogams			0
None		0	
Total % Living Cover			56.4
Average No. Vascular Species		22.5	

Table 3, continued

Scientific Name	Common Name	C x F Rel. Abundance	Avg. % Total Cover
SAGEBRUSH (1 stand sampled from White River water corridor)			
Shrubs			38.0
Artemisia tridentata	big sagebrush	690.0	
Atriplex confertifolia	shadscale	60.0	
Grayia spinosa	spiny hopsage	30.0	
Tetradymia spinosa	spiny horsebrush	30.0	
Certoides lanata	winterfat	10.0	
Grasses			0
None		0	
Forbs			0
None		0	
Annuals			32.0
Bromus tectorum	cheat grass	750.0	
Halogeton glomeratus	halogeton	480.0	
Cryptogams			0
None		0	
Total % Living Cover			70.0
Total No. Vascular Species		13.0	

NOTE: Relative abundance of big sagebrush is likely to be higher in the east project area than this figure indicates.

Table 3, continued

Scientific Name	Common Name	C x F Rel. Abundance	Avg. % Total Cover
JUNIPER (1 stand sampled)			
Shrubs & Trees			34.0
Juniperus osteosperma	juniper	111.3	
Artemisia tridentata	big sagebrush	73.5	
Chrysothamnus viscidiflorus	sticky-flowered rabbitbrush	44.1	
Grasses			3.9
Oryzopsis hymenoides	Indian rice grass	29.4	
Agropyron smithii	crested wheat grass	14.7	
Hilaria jamesii	galleta grass	9.8	
Perennial Forbs			3.9
Lepidium montanum	peppergrass	19.6	
Annuals			6.9
Gilia leptomeria	Great Basin gilia	24.5	
Bromus tectorum	cheat grass	14.7	
Salsola kali	Russian thistle	14.7	
Cryptantha crassisepala	cryptantha	9.8	
Chenopodium fremontii	chenopod	4.9	
Cryptogams			0
None		0	
Total % Living Cover			48.7
Total No. Vascular Species		17.0	

Figure 18. The Juniper community west of Squaw Ridge is characterized by low ridges separated by flood-plains which support a grasslands community.

Figure 19. Sage zone in the east project area, with Dinosaur National Monument in the distance. Note uniformity of ground cover.

of shadscale (Atriplex confertifolia) and horsebrush (Tetradymia spinosa). Grasses, cheatgrass (Bromus tectorum), African mustard, other annuals and forbs, and isolated greasewoods are found in this community. Lower elevation, more xeric conditions, and possibly soil differences are the bases for differentiation from the sage community. Figure 16 shows a typical desert shrub ground cover.

Greasewood Community

Washes and floodplains are characterized by dense greasewood and big sagebrush growth. Scattered willows (Salix exigua) and isolated clumps of tamarisk (Tamarix pentandra) and cottonwood (Populus fremontii) also occur in larger drainages. Allan (1979:43) notes that intermittent water and trees draw grazing animals to this community, resulting in overgrazing and an abundance of "increaser" type annuals such as cheatgrass. Typical vegetation is present in Coyote Wash and its floodplain, shown in Figure 17.

Riparian Community

This community differs by presence of tall grasses and large stands of cottonwoods from the greasewood community described above. However, greasewood community species are also present. Bee plant (Cleome serrulata or lutea) grows in thick stands along the White River, with other annuals. Seep environments located during the survey approximate this riverine environment, and support chokecherry, squawbush, serviceberry and tall grasses. Figure 20 shows the riparian vegetation strip along the White River at its confluence with Cowboy Canyon. The zone is abruptly demarcated from surrounding desert shrub zones. Dominant species are not included in Table 3 because the community was not sampled by Allan.

Grasslands

This community is found on isolated areas surrounded by other communities, mainly on drainage floodplains (Fig. 18). Composition varies, with cheatgrass, galleta grass and needle-and-thread grass dominating. Annuals contribute to ground cover. Thick stands of winterfat (Certoides lanata) are present in some areas.

Barren

Barren areas are not unusual in the western portion of the project area. Extremely sparse vegetation consisting of low forbs on hardpan desert pavement or hard-crust clay hills is characteristic. Figure 9 is typical.

Dune Association

As discussed by both Singer (1979) and Allan (1979, 1980), sand dunes in the project area support a plant association that differs in diversity and density from surrounding areas. Dominant shrubs include

Figure 20. A verdant strip of riparian vegetation lines the White River along its course, shown here at its confluence with Cowboy Canyon.

rabbitbrush, spiny hopsage, and four-wing saltbush. Indian rice grass is plentiful. Perennial forbs and annuals are also present, along with a thick growth of Russian thistle. Figures 14 and 15 show two dunes which support this association.

Species by species cover and frequency data for each community are presented in Appendix 6.

For a more detailed view of associations and communities in the studied portions of the project area, see Dr. Allan's works (1979, 1980).

Fauna

As with vegetation, faunal data collected for the Moon Lake environmental impact statement (Smith 1980a, b) are useful in evaluating the resources of the project area. It should be remembered that faunal resources are seasonal in some respects due to migration, hibernation and herd behavior patterns. Longer than annual cycles affect some populations, notably rabbits (Grady 1980:56-57). As Smith (1980a) reports, differences in microenvironment determine animal distributions, especially those of small rodents. His data are arranged by plant communities corresponding to Allan's.

A list of potentially available fauna compiled by Smith (1980a: 8-57) is presented in Appendix 7. As the list indicates, the area offers animal food resources which include plentiful mourning dove and leporid populations (Fig. 21); riparian bird species, fish, amphibians and beavers (Fig. 22) along the White and Green Rivers; and mule deer and antelope ranging over parts of the project area that are usually mutually exclusive (Figs. 23, 24). Seven species presently classified as game inhabit the study tract: chukars, ring necked pheasants (an exotic), desert cottontails, sage grouse (Fig. 25), mule deer, pronghorns and mourning doves. Other game species are migratory. It should be noted that Smith's study does not specifically include juniper zones in the Seep Ridge tract.

Since mourning doves nest several times a summer, producing an average of two or three broods of two eggs each (Smith 1980a:144), they represent a potentially very abundant resource. A variety of small rodents and mammals, notably white tailed prairie dogs (Fig. 26) and 13-lined ground squirrels (Fig. 27) also inhabit the area.

The resident mule deer population is confined to the juniper zone. Although Smith (1980a: Fig. 23) has placed the range predominantly in riparian bands, mule deer were observed in juniper areas several kilometers north of the White River and in juniper as far from the rivers as the vicinity of the town of Red Wash by archaeological field crews.

The remainder of the area provides range for antelope. The antelope population was decimated in the late 1800s and early 1900s by unregulated hunting and range destruction. Pronghorns were reintroduced

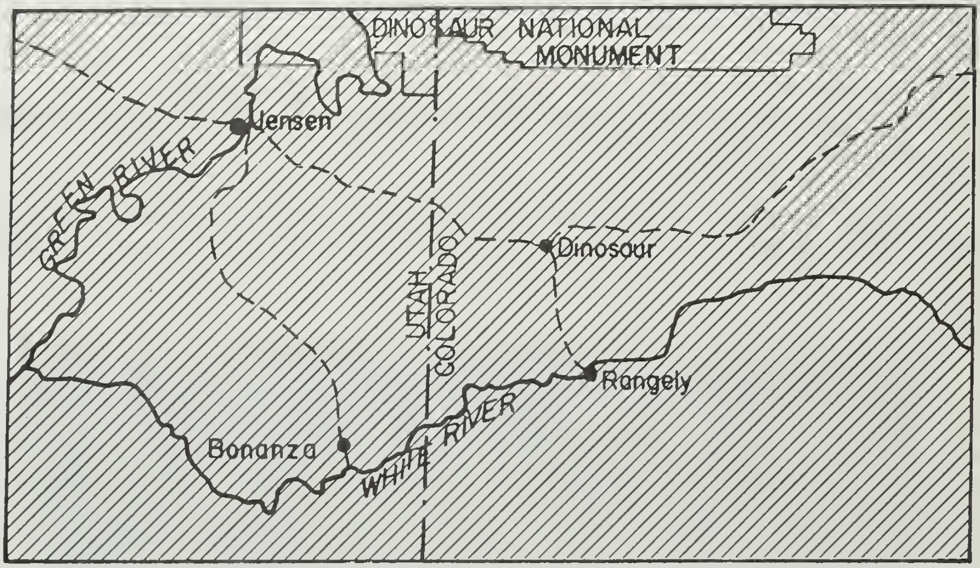


Figure 21. Distribution of mourning doves and desert cottontails (Smith 1980a: Fig. 10, Fig. 20) in and surrounding the Seep Ridge study tract, based on Smith's field assessments.

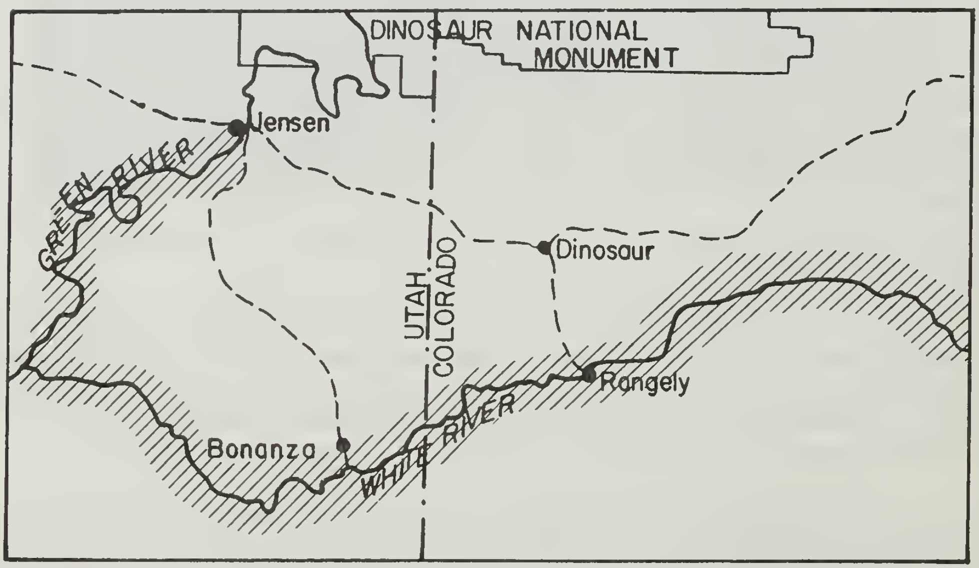


Figure 22. Distribution of waterfowl species and beavers (Smith 1980a: Fig. 11, Fig. 21) in and surrounding the Seep Ridge study tract, based on Smith's field assessments.

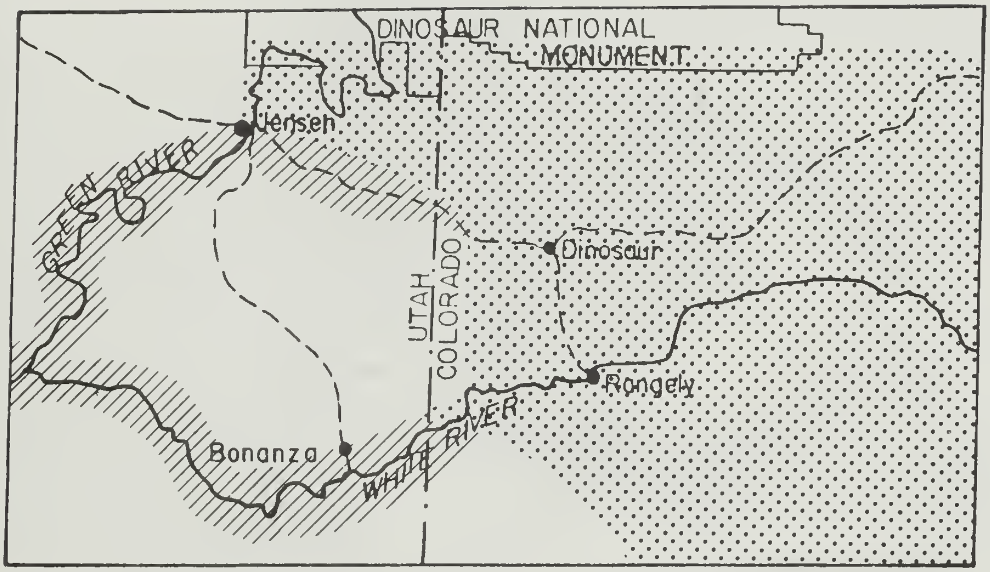


Figure 23. Distribution of mule deer (Smith 1980a: Fig. 18) in and surrounding the Seep Ridge study tract, based on Smith's field assessments. Stripes indicate residence; dots indicate winter range.

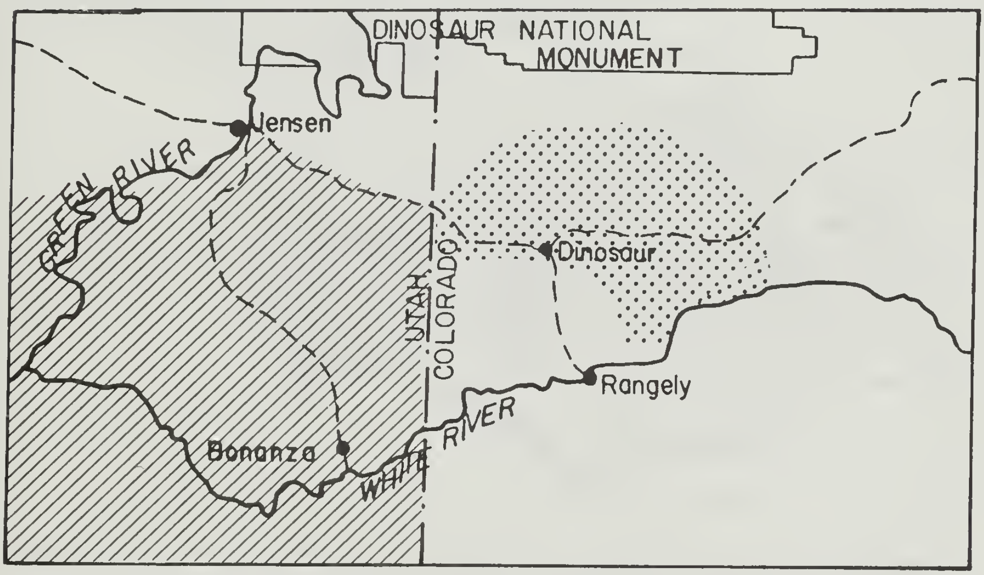


Figure 24. Distribution of pronghorns (Smith 1980a: Fig. 16) in and surrounding the Seep Ridge study tract, based on Smith's field assessments. Stripes indicate resident distribution; dots indicate migratory distribution.

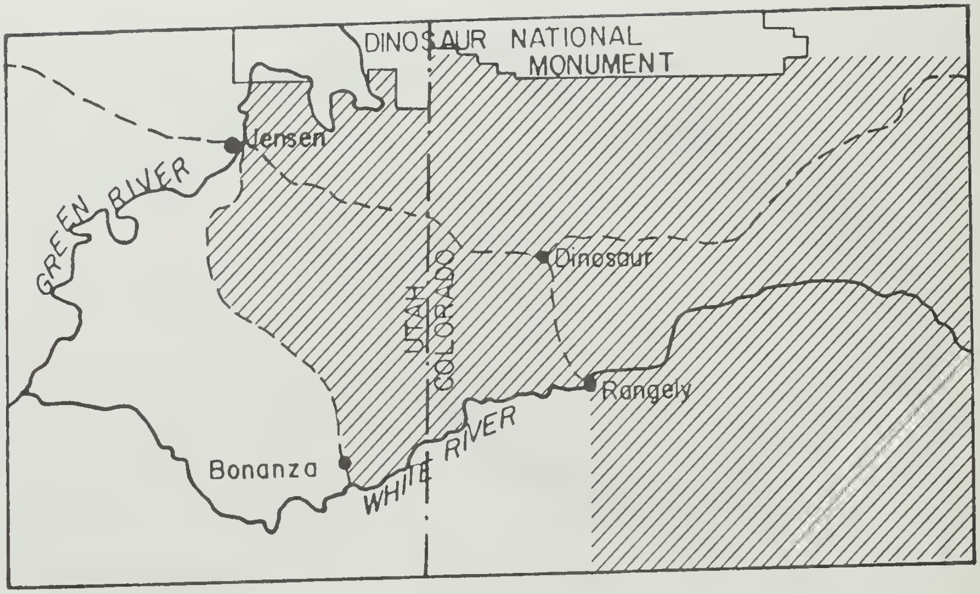


Figure 25. Distribution of sage grouse (Smith 1980a: Fig. 12) in and surrounding the Seep Ridge study tract, based on Smith's field assessments.

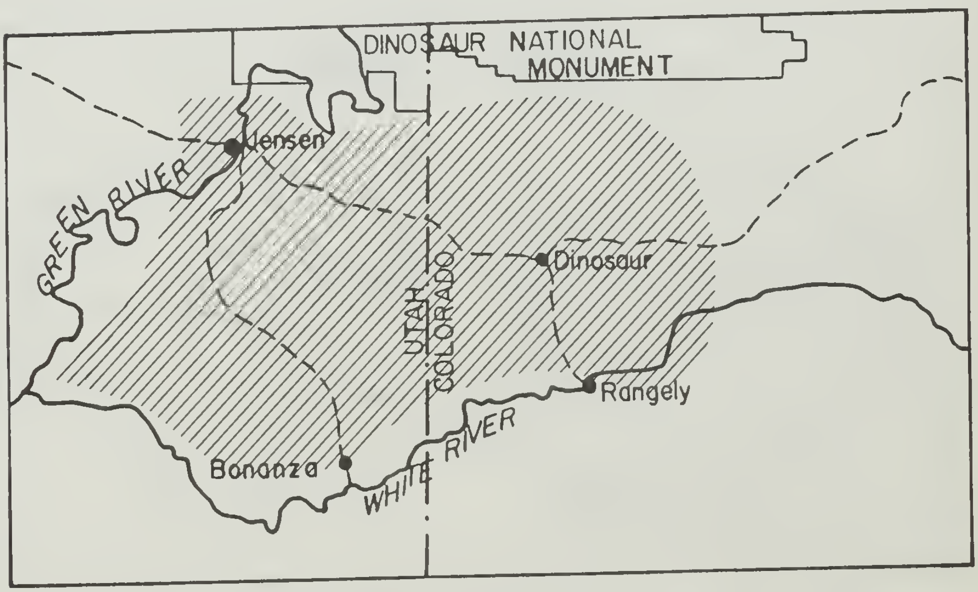


Figure 26. Distribution of white-tailed prairie dogs (Smith 1980a: Fig. 13) in and surrounding the Seep Ridge study tract, based on Smith's field observations.

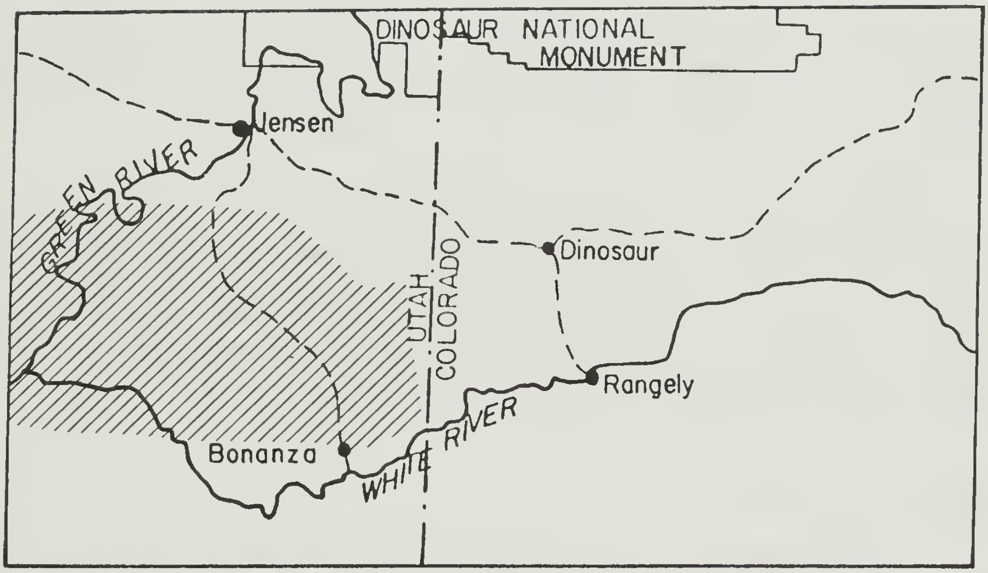


Figure 27. Distribution of 13-lined ground squirrels (Smith 1980a: Fig. 14) in and surrounding the Seep Ridge study tract, based on Smith's field observations.

to the area in the 1940s (Smith 1980a:167). The present herd is healthy and increasing, and antelope were frequently seen throughout the project area. Smith (1980a:166-167) doubts that the power plant and water corridor areas ever sustained a native antelope herd, presumably because the habitat is marginal. Prior to livestock grazing, however, range conditions may have been more suitable for this herbivore, as suggested by Udy (1953: Fig. 10, p. 11), who includes the entire Uintah Basin in the original range for antelope. Northern Utes report hunting pronghorns (Smith 1974:55-56), so herds were likely present in the Uintah Basin if not in the project area.

Bison were noted in the Uintah Basin by the Dominguez-Escalante Expedition in 1776. These herds apparently became extinct around 1850 (Steward 1937).

Predators in the area include coyotes, bobcats, badgers, golden eagles and a wide variety of hawks. Although in competition with humans for animal prey, these animals also provide pelts and feathers, and some, owls for example, have been utilized for food (Smith 1974:60). Reptilia (Appendix 7) and insects are also available.

The Moon Lake terrestrial vertebrate studies utilize the plant community studies in grouping animal distributions by habitat. One criterion for assessment of impact for vertebrate studies is habitat disturbance (Smith 1980a:182). Impact is judged to be more severe on diverse habitats. As Table 4 shows, sagebrush and sagebrush/riparian habitats support the greatest variety of birds and mammals, while greasewood and mixed desert shrub environments support the least diversity of species.

Range Conditions

Before conclusions are drawn about the inhospitable nature of most of the arid land immediately north of the White River, it must be realized that this area has been badly overgrazed. Allan (1979:11) lists two major changes in vegetation from the original ground cover: 1) decrease in numbers of individual plants to far below useful amounts for forage; 2) change in floristic composition by replacement of native species by exotic competitors that are less valuable for forage and soil stabilization. Cheatgrass, Russian thistle and African mustard are prominent exotics. Datsrup (1963) reports that not only was this land reported to be covered with meadow grasses in the past, but recent deep arroyo cutting is related to the change in vegetation.

An interesting facet of range discussion is Dr. Allan's (1979:36, 80) assessment that, although none of the communities he studied could presently be considered prime rangeland by BLM and National Forest Service standards, sand dune associations come closest, with grassland following.

The sheep industry expanded into the area in the last decades of the nineteenth century and unregulated grazing reached an all-time high

Table 4. Importance of habitat types to terrestrial vertebrate groups as measured by vertebrate species diversity.*

Vertebrate group	Mixed desert shrub	Greasewood	Atriplex	Sagebrush	Pinyon-juniper-sagebrush	Pinyon-juniper	Greasewood-juniper	Grass	Riparian	Riparian-sage
Birds	2.46	2.35	3.01	4.71	3.25	2.86	3.07	5.31	2.78	2.73
	2.51	2.12						2.52	2.49	
	2.32	2.36						1.87		
	.83									
	2.53									
	$\bar{X}$=2.13	$\bar{X}$=2.28	$\bar{X}$=3.01	$\bar{X}$=4.71	$\bar{X}$=3.25	$\bar{X}$=2.86	$\bar{X}$=3.07	$\bar{X}$=3.23	$\bar{X}$=2.64	$\bar{X}$=2.64
Mammals	2.06	.45	1.07	.74	.57	.13	1.13	2.28	.60	1.72
	1.48	.29						.46	.18	
	0	.34						1.27		
	.22									
	.99									
	$\bar{X}$= .95	$\bar{X}$= .36	$\bar{X}$=1.07	$\bar{X}$= .74	$\bar{X}$= .57	$\bar{X}$= .13	$\bar{X}$=1.13	$\bar{X}$=1.34	$\bar{X}$= .39	$\bar{X}$=1.72
Herptiles	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = not sufficient data to calculate diversity index

*from Smith 1980a:182

in the early 1900s (Udy 1953:11). Several large shearing camps attest to the study tract's continuing popularity as winter range. The herd of wild horses in the study tract also contributes to range destruction. The horses compete with antelope and livestock for forage (Smith 1980a: 165-166).

Summary of Potential Resources

From the above discussion, a picture of past resource availability if not plenty emerges. Plant and animal resources can be obtained at least seasonally. Shelter is provided in the form of high ridges, rock outcroppings, dune depressions and vegetation. Tool manufacturing stone can be locally quarried.

Necessary for utilization of these resources is an intimate knowledge of the local physical environment and of local ecology, notably of seasonal cycles. Although agriculture is a possibility in some limited local areas, it seems that the area served as a broad hunting and gathering base for human populations including those who practiced agriculture on the not-too-far distant floodplains of Douglas Creek in northwestern Colorado and Cub Creek and other streams at the base of Blue and Split Mountains.

CHAPTER 3

CULTURAL RESOURCES IN THE PROJECT AREA

General

Forty-one sites and 106 isolated finds were recorded during the Seep Ridge Cultural Inventory. Of the sites, six are Euro-American historic, 29 are prehistoric, and five have both prehistoric components and historic components earlier than 50 years old. One historic structure was recorded outside the sample units and will not be included in site analysis although it is described below. Of the isolated finds, 43 are historic, 63 are prehistoric. All sites recorded in the project area are shown on Figures 28, 29, 30, and 31.

A site was defined as a locus of features or artifacts resulting from some definable human activity that took place at least 50 years ago. Sites were distinguished from isolated finds on the basis of artifact density and discernible site function. In all prehistoric locales, this distinction was clear cut and all isolated finds consist of fewer than four artifacts. In historic locales, however, the distinction was not as clear because of the frequent presence of artifacts more recent than the 50-year guideline. Locales with more than four artifacts but with indiscernible function and artifacts predominantly more recent than 1930 were designated as isolated finds. These are summarized in Appendix 3. Despite the less stringent definition, only two of the historic isolated finds consist of more than four artifacts.

Trash and historic features less than 50 years old or indeterminate in age were marked on the topographic maps and briefly described in the field book but not recorded. Such evidence of recent activity includes corrals, oil and gas drilling trash, recent sheepherders' camps, recent hearths and cairns, and historic non-diagnostic isolated artifacts.

Site Types

Prehistoric sites can be loosely segregated into two groups based on function: limited activity areas and short-term habitations (campsites). Presence of hearths, ground stone, or ceramics has been used to define campsites. It is recognized that this sorting is based on the assumption that presence of certain artifacts or features indicates a longer duration stay and more varied activities at a campsite than at a limited activity area. Undoubtedly, some overlap is involved. For example, campsites may be misclassified as limited activity sites if hearths are not visible on the surface; limited activity sites with evidence of burned areas may not have actually been used as campsites; presence of ground stone, especially a single mano, is problematical and may not by itself indicate that a small lithic scatter was used as a campsite; a large lithic scatter with a varied tool inventory but no features or ground stone may have been occupied more intensively than a single hearth with one artifact. In short, these site types conform to actual prehistoric use patterns only in a very gross way.

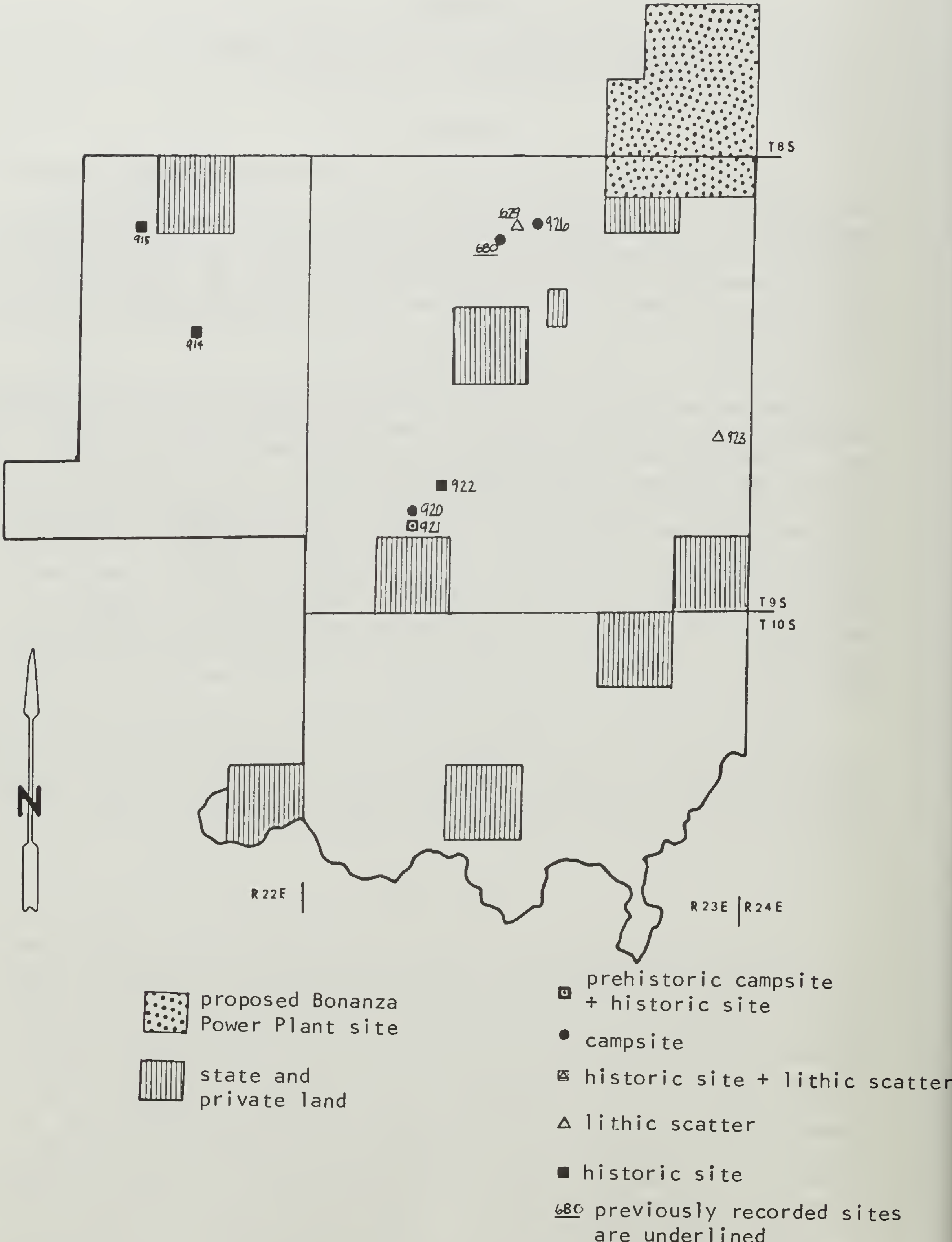


Figure 28. Sites recorded in the west third of the project area. Previously recorded sites are underlined.

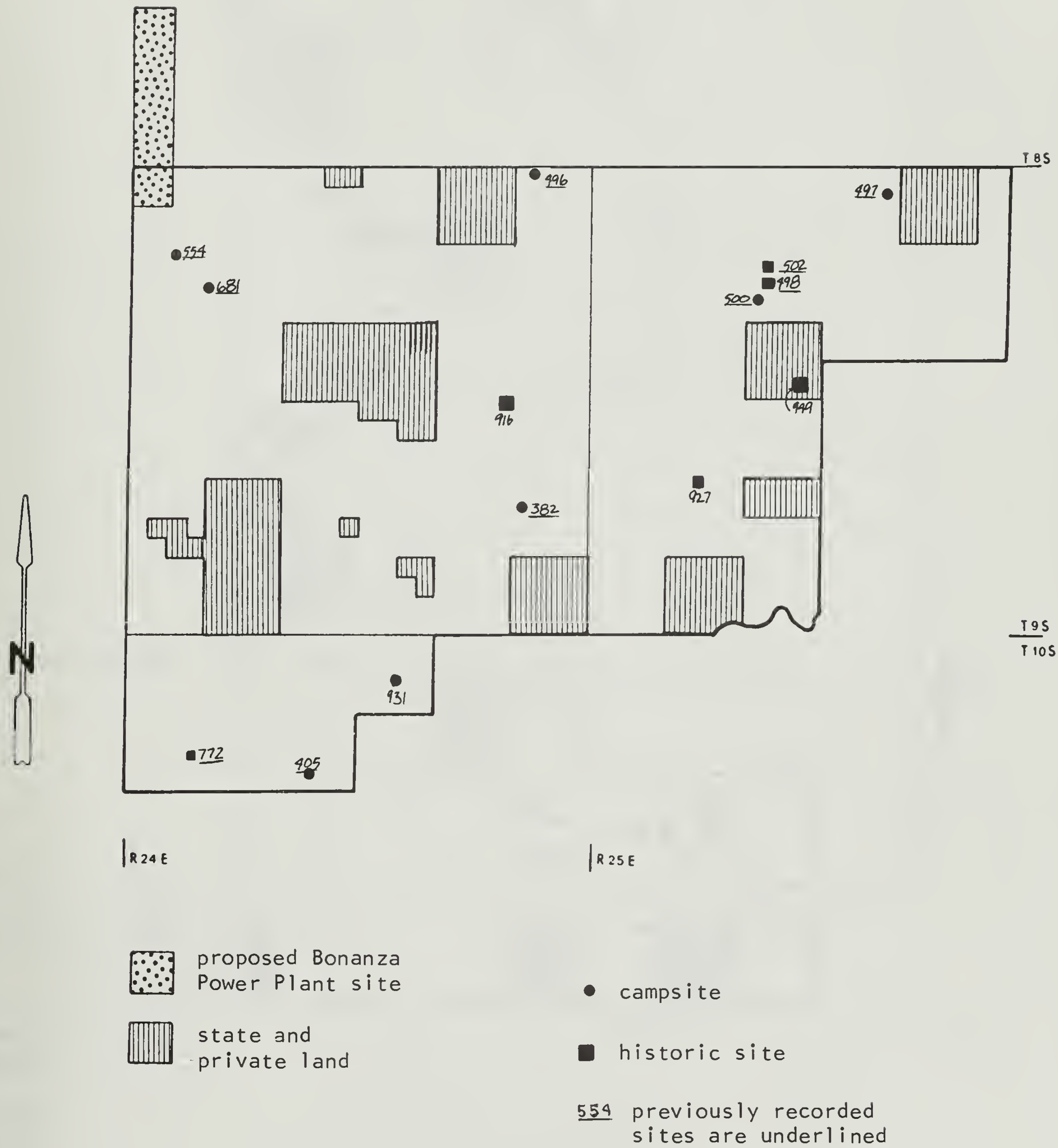


Figure 29. Sites recorded in the central third of the project area. Previously recorded sites are underlined.

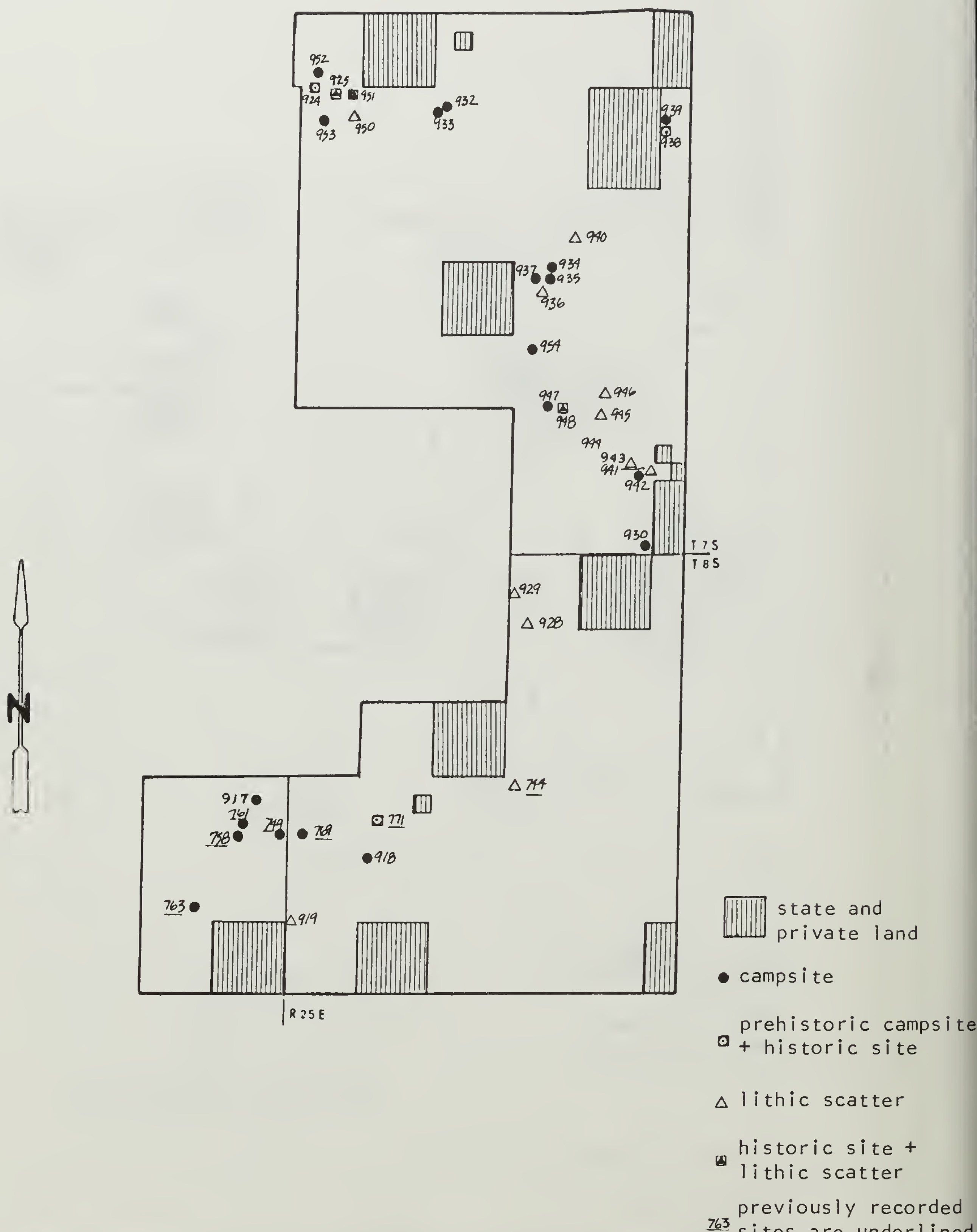


Figure 30. Sites recorded in the northeast third of the project area. Previously recorded sites are underlined.

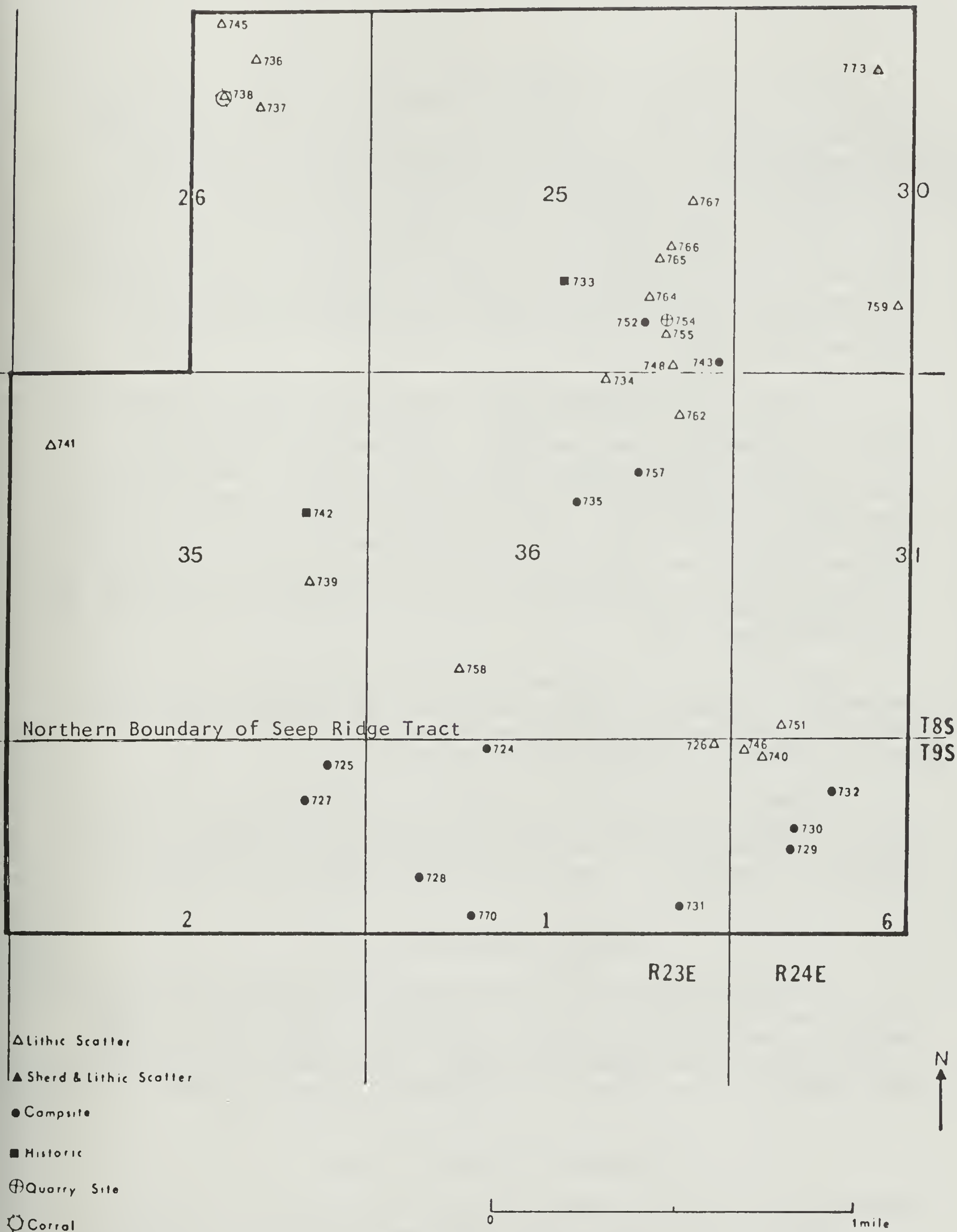


Figure 31. Site type and distribution of previously recorded archaeological sites in the proposed Bonanza Power Plant site. 100% of the plant site has been inventoried (Chandler and Nickens 1979b).

Site function is summarized by feature and artifact assemblage in Table 5 and Figure 32. The continuum of intensity of use can be discerned more easily there. This "polythetic" approach to site function has been used by Williams, Thomas, and Bettinger (1973) and by Toll (1977:35-49). Aside from the six attributes in Table 5, Toll's list of attributes also includes presence of a structure, omitted in the table because none of the sites have structures. Toll separates living sites from limited activity sites on the "somewhat arbitrary" basis of presence of three of his seven attributes. According to this method of distinguishing site function, a total of 20 campsites (58.8%) and 14 limited activity sites (14.2%) were recorded during the Seep Ridge Cultural Inventory.

It can also be postulated that limited activity areas had specific uses, e.g. as hunting camps. Surface artifact assemblages are very sparse for almost all the prehistoric sites, however. Although such specialized use is suggested to some extent by artifact assemblage and site location, testing or more extensive excavation is required before these ideas can be verified. Defining cultural affiliations and temporal limits of the sites is even more tenuous, since diagnostic artifacts are lacking at most sites. Ceramics are present at two sites, and "diagnostic" projectile points were located at nine sites but some of these points have a range so broad that neither culture nor time period can be derived with certainty (Holmer 1978).

Historic site functions are also surmised by feature and artifact assemblage. Including the multi-component sites, seven campsites, one horse trap, one cooking pit, and one enigmatic site with a series of masonry storage (?) structures were recorded.

Artifacts are discussed in the material culture section at the end of this chapter. Additional site and isolated find information is presented in Appendices 2, 3, and 4. National Register considerations are discussed in Chapter 6. Fossil locales are summarized in Appendix 5.

Previously Recorded Sites

In addition to the 41 sites recorded during the Seep Ridge survey, 32 sites were previously recorded in the project area. These are summarized in Table 6. Figure 31 shows previously recorded archaeological sites in the proposed Bonanza Power Plant site. 100% of this high site density area was inventoried in 1979 (Chandler and Nickens 1979b).

Prehistoric Site Descriptions

42UN917 is an extensive, sparse artifact scatter with most cultural material confined to a large stabilized sand dune located on the southeast edge of Deadman Bench overlooking Coyote Basin. Vertebrate fossil scatters are found on the barren clay slope below the site. Approximately 100 flakes, both chert and quartzite, were located in an area 350 meters by 170 meters. No features

Table 5. Prehistoric site attributes

Site #	Chipped Stone Tools**	Grinding Tools	Ceramics	Hearth or Burned Area	Overhang or rock outcropping	slope: flat area ($0-5^{\circ}$)
42UN917	X	X				X
42UN918	X	X		X		X
42UN919	X					X
42UN920	X	X		X	X	X
42UN921	X	X			X	X
42UN923	X					X
42UN924	X	X		X		X
42UN925	X					X
42UN926	X	X				X
42UN928						X
42UN929	X					X
42UN930	X			X		X
42UN931	X	X	X	X	X	X
42UN932	X	X				X
42UN933		X		X		X
42UN934	X	X		X*		X
42UN935	X	X		X		X
42UN936	X					X
42UN937				X		X
42UN938	X	X				X
42UN939	X	X		X		X
42UN940	X			X*		X
42UN941	X			X		X
42UN942	X			X		X
42UN943	X			X*	X	X
42UN944	X					X
42UN945	X				X	X
42UN946						X
42UN947	X	X				X
42UN948	X					X
42UN950				X?		X
42UN952	X	X		X		X
42UN953		X		X		X
42UN954	X		X	X		X
Total and % of occurrence	28 (82.4%)	16 (47.1%)	2 (5.9%)	18 (52.9%)	5 (14.7%)	34 (100%)

* = burned stone
** includes utilized and retouched flakes and hammerstones

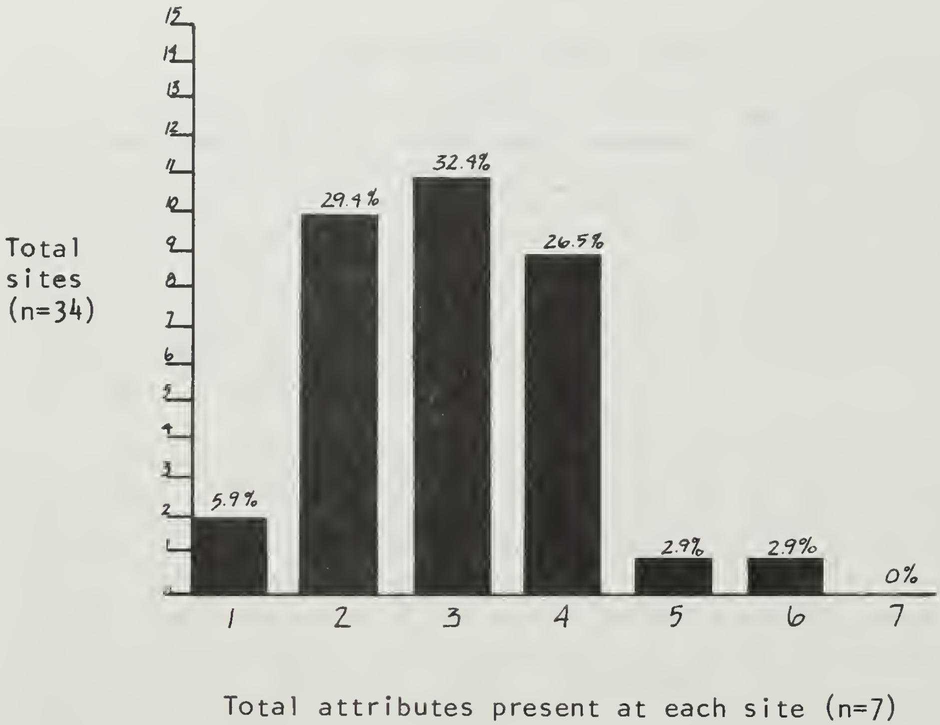


Figure 32. Attribute distribution for the 34 prehistoric sites recorded during the Seep Ridge Project. Sites with few attributes are limited activity sites. Sites with many attributes are campsites. The seven attributes tallied were presence of:
- chipped stone tools
- grinding tools
- ceramics
- hearth or burned area
- overhang or rock outcropping
- flat area
- structure

(Toll 1976)

Table 6. Previously recorded sites - Seep Ridge Project Area

Site Number	Site Type	Fig.	Reference
42UN382	prehistoric campsite	29	BLM Files
42UN405	prehistoric campsite	29	Berry and Berry 1976
42UN496	prehistoric campsite	29	Weber et al. 1977
42UN497	prehistoric campsite	29	Weber et al. 1977
42UN498	historic campsite	29	Weber et al. 1977
42UN500	rockshelter (prehistoric campsite)	29	Weber et al. 1977
42UN502	rock structure (historic?)	29	Weber et al. 1977
42UN554	prehistoric campsite	29	BLM Files
42UN679	lithic scatter	28	Simms 1979
42UN680	prehistoric campsite	28	Simms 1979
42UN681	prehistoric campsite	29	Simms 1979
42UN724	prehistoric campsite	31	Chandler and Nickens 1979b
42UN725	prehistoric campsite	31	Chandler and Nickens 1979b
42UN726	lithic scatter	31	Chandler and Nickens 1979b
42UN727	prehistoric campsite	31	Chandler and Nickens 1979b
42UN728	prehistoric campsite	31	Chandler and Nickens 1979b
42UN729	prehistoric campsite	31	Chandler and Nickens 1979b
42UN730	prehistoric campsite	31	Chandler and Nickens 1979b
42UN731	prehistoric campsite	31	Chandler and Nickens 1979b
42UN732	prehistoric campsite	31	Chandler and Nickens 1979b
42UN740	lithic scatter	31	Chandler and Nickens 1979b
42UN744	lithic scatter	30	Chandler and Nickens 1979a
42UN746	lithic scatter	31	Chandler and Nickens 1979b
42UN749	prehistoric campsite	30	Chandler and Nickens 1979a
42UN758	prehistoric campsite	30	Chandler and Nickens 1979a
42UN761	prehistoric campsite	30	Chandler and Nickens 1979a
42UN763	prehistoric campsite	30	Chandler and Nickens 1979a
42UN769	prehistoric campsite	30	Chandler and Nickens 1979a
42UN770	prehistoric campsite	31	Chandler and Nickens 1979b
42UN771	prehistoric campsite and historic structure	30	Chandler and Nickens 1979a
42UN772	historic structure	29	Chandler and Nickens 1979b
42UN893	prehistoric campsite	31	Reed 1980a
42UN894	lithic scatter	31	Reed 1980a
42UN895	prehistoric campsite	31	Reed 1980a

were observed. Tools at the site include one ovoid handstone, one white chert scraper, six cores, one enigmatic bifacially flaked pumpkin chert tool, and one corner-notched heat-treated pumpkin chert Elko or Pinto Series projectile point. Sage, greasewood, saltbush, grasses, and desert annuals grow on the bench, with slightly greater vegetative density on the dune. Elevation is 5400-5420'. A large intermittent tributary to Coyote Wash is 300 meters south of the site.

42UN918 is an extensive artifact scatter located on a sand dune at the edge of an intermittent tributary to Coyote Wash. The site covers a 205 meter by 60 meter area over which was found burned rock and ash, nine metates and 11 manos, numerous cores and debitage, one hammerstone, four utilized flakes, one projectile point midsection, and one large corner-notched Elko Series projectile point. A cultural horizon approximately 1.5 meters in thickness was observed in the wall of the wash up to 1 m below site surface. It consists of a large amount of ash, some charcoal, and a fire pit in cross section. Artifacts are present in the wash itself, and the site is in the process of eroding away. Elevation is 5300'. Vegetation on site includes sagebrush, rabbitbrush, greasewood, Russian thistle, cheat grass, other grasses, and low annuals.

42UN919 is a large, dispersed lithic scatter located in a north-flowing intermittent tributary to Coyote Wash. The site is sheltered between a large stabilized dune immediately to the east and a barren clay slope below a sage-covered bench to the west. No features or ground stone were observed at the site. A total of 32 flakes, most interior chert, was inventoried. Most are located in two flake concentrations, one at the northwest and one at the southeast end of the site. A variety of high quality brown cherts are present, along with obsidian. Five utilized flakes, six biface fragments, one large core, and two projectile point fragments were located. One point conforms to Pinto-Duncan-Hanna point descriptions; the other is a Cottonwood Triangular point. This may indicate that the site has both an Archaic component and a Fremont or Shoshonean component. The site is exceptional in the high proportion of tools to flakes. Coyote Wash itself is located approximately 500 meters to the northwest. Greasewood, hopsage, shadscale, cheat grass, fleabane, snakeweed, and low annuals grow on the site.

42UN920 is one of two prehistoric rockshelters recorded during the project It is situated in a sandstone outcropping on the south face of a low bluff, overlooking a small drainage basin, and is 60 meters by 40 meters in size. Two small alcoves approximately 30 meters apart both contain cultural material. In the easternmost is a hearth consisting of an irregular cluster of burned sandstone. The ceiling of the alcove is blackened. A slab metate lies at the hearth. A thick deposit of sheep or antelope dung covers the ground surface. In the westernmost is a poorly defined 1.5 meter diameter semicircular alignment of large sandstone slabs and cobbles, possibly natural. A hammerstone was found nearby and flakes are sparsely

scattered downslope. Bone fragments and thick animal dung are also present here. Atop the outcropping is a large hearth, probably historic judging by size and preservation. Flakes are sparsely scattered downslope from the shelter. Artifacts include two hammerstones, two mano fragments, 11 cores, four retouched or utilized flakes, and a total of 54 predominantly interior chert and quartzite flakes, some heat-treated. No diagnostic artifacts were observed. The site lies on the section line and may have been surface collected by surveyors or by occupants of 42UN921 300 meters to the south. A desert shrub community with greasewood, hopsage, cheat grass, and Russian thistle grows at the site. Low, sparse willows indicate possible presence of a seep. Elevation is 5300'.

42UN923 is a small cluster of artifacts located on a terrace approximately 100 meters southwest of a high butte. The site covers a 10 meter by 8 meter area and consists of five interior flakes (one utilized) and one chert scraper. Large intermittent drainages cut through the terrace within 50 meters to the north and south, and sparse desert shrubs grow on the site. Elevation is 5240'. No features or diagnostic artifacts were observed.

42UN926 is an extensive artifact scatter, most of which is located in a blowout at the west edge of a low, longitudinal east-west trending dune and in the sandy, grassy flats at the base of the dune. Site dimensions are 179 meters by 115 meters. Two artifact concentrations are present, one at the dune edge and a second approximately 40 meters south. A metate, a fragment from a second metate, and a chert preform were found approximately 30 meters east of the first concentration. The site is characterized by an abundance of ground stone (five manos in addition to the metates mentioned above), cores (ten), and bifaces or preforms (three). Approximately 50 predominantly interior chert and quartzite flakes are present. No features or diagnostic artifacts were observed. An unnamed intermittent tributary to Coyote Wash is located approximately 100 meters west of the site, with riparian vegetation along its banks. Vegetation on the site itself includes rabbitbrush, greasewood, shadscale, hopsage, cheat grass, Indian rice grass, and low annuals, all denser on the dune to the east. Elevation is 4940'. A 1 meter diameter scatter of vertebrate fossils was found at the first concentration.

42UN928 is a dispersed scatter of flakes along the west slope of a bench above Coyote Basin and on the south side of an intermittent drainage separating two west-trending ridges. It covers an area 70 meters by 67 meters. The site is probably a core reduction location. Three oolitic chert cores and five oolitic chert flakes are present, along with two gray quartzite flakes and a leather harness strap. No features or diagnostic artifacts were observed. Elevation is 5540'. Snakeweed, shadscale, grasses, and sparse sagebrush and greasewood grow at the site, and sparse junipers grow on the ridge to the south.

42UN929 is a dispersed lithic scatter located along the top and higher terraces of a northeast-southwest trending ridge. The site measures 310 meters by 70 meters. Two artifact concentrations were observed. The first appears to be confined to the ridge top and consists of an extremely sparse scatter of 24 oolitic chert flakes. Chert cobbles and a recent sparse trash scatter are also found on the ridge top. This portion of the site commands an excellent view in all directions. The second concentration is located 45 meters south of the first concentration on a low arm of the ridge. A core, two biface tips, one utilized obsidian flake, and 11 nonutilized flakes were located here, covering an area 75 meters by 47 meters. No cultural features or diagnostic artifacts were observed. Juniper, sagebrush, grasses, shadscale, greasewood, and composites grow on the site. Elevation is 5600'. The site is located within 500 meters of several major intermittent streams that drain southwest into Coyote Basin.

42UN930 consists of a small ashy area approximately .25 meter in diameter. Small pieces of burned rock and a quartzite biface tip lie on the ashy surface. No other features or artifacts were observed. The site is situated on a broad sage-covered ridge at an elevation of 5740'. An intermittent drainage flows southwest approximately 100 meters east of the site.

42UN931 is a rockshelter with five associated hearth areas and a sixth area comprising several small lithic concentrations. The site, which covers a 160 meter by 80 meter area, is located at a shallow overhang in an area characterized by juniper-covered bluffs, ridges, and terraces with the White River canyon 1.4 km south. Four Emery Gray sherds, a mano, a mano fragment, a quartzite biface tip, and a chopper were found in association with the shelter itself. To the southeast approximately 40 meters is a cluster of eight very dense lithic concentrations, each less than 1 square meter in diameter, with a total of 229 flakes. Although the site has been badly vandalized, these concentrations do not appear to be "collectors' piles" and were frequently observed elsewhere in the project area on unvandalized sites. Also included in this area are two small ashy soil concentrations, one Emery Gray indented rim sherd, one end scraper, and one Desert Side Notched projectile point fragment. Other hearth areas consist of ashy soil and fire-cracked rock, usually with several flakes present, one with a mano. One utilized and 11 nonutilized obsidian flakes were located. Three large potholes and backdirt piles are found near the shelter and a fourth is located in the flake concentration area, along with an historic hearth. This probably accounts for the near absence of diagnostic artifacts. Ceramics and the projectile point fragment indicate a Fremont occupation. Inspection of the potholes leads to the conclusion that some depth of cultural material is present. Elevation is 5520'. A large intermittent drainage flows southwest approximately 50 meters south of the site.

42UN932 is a localized lithic scatter measuring 15 meters by 12 meters and consisting of approximately 30 predominantly interior chert and quartzite flakes. Three mano fragments and a utilized chert biface were also observed. The site is situated in a blowout on a dune-covered ridge top at the northeast base of Raven Ridge in a juniper zone but near the juniper-sage ecotone. No features or diagnostic artifacts were observed. Several small intermittent drainages are within 100 meters of the site and Snake John Wash, a major drainage, is 2.2 km east. Elevation is 5680'.

42UN933 is a small campsite located on a ridge slope at the northeast base of Raven Ridge, partially in a blowout area and partially in dunes. Two possible hearths consisting of fire-cracked rock and ashy soil are present in the 30 meter by 20 meter site area. Approximately 30 predominantly interior chert and quartzite flakes and one shallow basin metate were found. The site is located in the juniper zone, near the juniper-sage ecotone. Several small intermittent drainages flow within 100 meters and Snake John Wash, a large intermittent drainage, is 2.3 km east. Elevation is 5710'.

42UN934 is a dispersed scatter of flakes on a low juniper-covered ridge top at the east base of Raven Ridge above a gently sloping sage basin. Approximately 24 flakes are present in a 108 meter by 20 meter area, with a flake concentration and a scatter of burned sandstone 5 meters in diameter to the northwest. Most flakes are oolitic chert; the only quartzite on the site is a prepared tool. One pink quartzite biface tip, two utilized flakes, and one mano were found, but no diagnostic artifacts or features were observed. Elevation is 5880'. A small intermittent drainage borders the site, and Snake John Wash is located 800 meters east.

42UN935 is a campsite located on several low convoluted juniper-covered ridges at the east base of Raven Ridge. Two dark ashy areas were observed approximately 5 meters apart, at the heads of two small drainages. Oxidized sandstone fragments are scattered over a broad area 15 meters to the west. Flakes are concentrated down the drainages below the hearths. At least 60 predominantly oolitic interior flakes are present in the site's 75 meter by 20 meter area. One mano fragment, a hammerstone, two obsidian flakes, and a chert projectile point tip were observed. The site is near the juniper-sage ecotone and several small intermittent drainages are located nearby. Snake John Wash is 900 meters east. Elevation is 5920'.

42UN936 is a localized lithic scatter situated atop a juniper-covered ridge at the northeast base of Raven Ridge. A dense concentration of flakes approximately 15 meters in diameter forms most of the site, but at least 60 flakes are scattered over a 40 meter by 20 meter area. At the center of the concentration is a very dense pile of flakes less than 2 meters in diameter. Nearly all flakes are interior chert, and a variety of cherts are represented. One

utilized and retouched flake was observed, but no diagnostic artifacts or features were located. The site is near the juniper-sage ecotone and intermittent drainages border it on both sides of the ridge. Snake John Wash is 1 km east. The elevation is 5980'.

42UN937 is a concentrated scatter of interior flakes along a low north-east trending ridge at the northeast base of Raven Ridge. The site is in the juniper zone but is in an ecotonal area near the sage zone. At the site center is a 1 meter diameter burned dark ashy soil stain with a dense concentration of at least 41 flakes on it. Lithic heat treatment is suggested. Site dimensions are 56 meters by 25 meters. There are an estimated 80 to 100 flakes present, predominantly oolitic chert with very little quartzite. No ground stone or diagnostic artifacts were found. The elevation is 5940'. Intermittent drainages flank the site; Snake John Wash is 1 km east.

42UN939 is a large campsite located in the blowout of a dune immediately east of a deep north-flowing intermittent tributary of Snake John Wash. The site is characterized by a large amount of ground stone: at least four metates and four manos are represented. A large number of chipped stone tools and retouched and utilized flakes were observed. Two hearths are located on the blowout and a large scatter of burned rock and ground stone fragments covers the area. The site measures 48 meters by 56 meters. An old roadbed and probable historic hearth are located approximately 20 meters to the north, and a metate fragment was found approximately 50 meters north on another large dune. At least 100 flakes are present, predominantly interior chert. One projectile point with rounded base and several bifaces were located. A small stand of juniper grows on the site, along with rabbitbrush, Indian rice grass, snakeweed, sage, and other grasses. Elevation is 5780'.

42UN940 is a dispersed lithic scatter on a high dune at the junction of a deep intermittent drainage to the south and Snake John Wash to the east. A stand of junipers grows on the east side of the dune but the surrounding ecotone is sage dominated, with dense ephedra, rabbitbrush, Indian rice grass, desert buckwheat, and other grasses growing on the large semi-stabilized dunes along the wash. The site, which measures 75 meters by 9 meters, consists of two concentrations, one at the south edge of the dune and one approximately 60 meters northwest in a small blowout. The first is a scatter of burned rock and a dense flake concentration, with one chert biface midsection. In the second there are three small, dense flake piles, each measuring less than .5 meter in diameter. Oxidized sandstone fragments litter this area. A sparse scatter of flakes along the ridge of the dune connects the two concentrations. Approximately 200 flakes, predominantly oolitic chert interior, are present. No diagnostic artifacts, features, retouched or utilized flakes, ground stone, or quartzite were evident. Elevation is 5800'.

42UN941 is a dispersed lithic scatter along the top of Squaw Ridge immediately northwest of a gap in the ridge. The site commands an excellent view of Coyote Basin and Deadman Bench to the southwest. Site dimensions are 86 meters by 17 meters. A small scatter of oxidized sandstone was observed, but it may be natural. One corner-notched Elko Series projectile point base, one utilized flake, two cores, and 27 flakes constitute the artifact inventory. The site may have been a combination lithic reduction area and hunting locale. Elevation is 6020'. Juniper, shadscale, sage, grease bush, grasses, and low annuals grow on the site.

42UN942 is a localized lithic scatter on a knoll immediately south of the top of Squaw Ridge, near a gap in the ridge. Site area is 50 meters by 30 meters. Oxidized sandstone covers the ground surface. Three projectile points (one fragmentary, one Desert Side Notched, one Cottonwood Triangular) and a preform were found in a small 1 meter diameter concentration of stained soil and oxidized sandstone. Numerous retouch flakes were observed on an anthill 5 meters west of the stained soil; one was obsidian. This suggests the presence of buried cultural material. A core and two burned bone fragments were located nearby. Approximately 75 flakes were inventoried, mostly oolitic chert interior flakes. Juniper, composites, Western peppergrass, shadscale, sage, and grasses grow on the site. Elevation is 5940'. An intermittent drainage flowing southwest from the ridge is 150 meters northwest of the site.

42UN943 is a dispersed lithic scatter on the top of Squaw Ridge, commanding an excellent view of Coyote Basin to the southwest and of the valley between Raven and Squaw Ridges to the northeast. The site is located in a gap between two high points of the ridge; at the east end is a north-facing sandstone overhang with a scatter of oxidized sandstone and a burned area beneath the overhang, possibly natural. The artifact inventory includes one Desert Side Notched chert projectile point base, one projectile point fragment with impact fracture at the tip, one obsidian biface fragment, two retouched chert flakes, and 15 interior and secondary flakes, predominantly chert. No features were evident. On an anthill located near the site center were found numerous retouch flakes, indicating that the site has some depth. Vegetation includes juniper, composites, shadscale, Western peppergrass, and low annuals. The site, which measures 75 meters by 45 meters, is located at an elevation of 5980'.

42UN944 is a small, concentrated scatter of lithics at the southwest base of Squaw Ridge. It consists of two .5 meter diameter clusters of flakes approximately 10 meters apart. A hammerstone was found between the concentrations. Site dimensions are 18 meters by 10 meters. A total of 44 flakes was inventoried; most are interior quartzite and oolitic chert. No features or diagnostic artifacts were observed. The site setting is the ecotone between the juniper zone on the ridge and the grass-winterfat zone at the ridge base. Elevation is 5900'. An intermittent drainage flowing southwest from the ridge is located less than 100 meters to the north.

42UN945 is a small, dispersed flake scatter along the southwest base of a long, low sandstone ridge between Squaw Ridge and Raven Ridge. Eighteen flakes cover a 70 meter by 25 meter area. One retouched gray chert flake was located, and many tiny retouch flakes are present. No cultural features or diagnostic artifacts were found. A scatter of oxidized sandstone overlies the site, which is situated in the juniper zone but near the sage zone at the base of Raven Ridge. Elevation is 6040'. The intermittent drainage that flows between Raven and Squaw Ridges is 300 meters northeast.

42UN946 is a small lithic scatter at the southwest base of a low ridge between Squaw Ridge and Raven Ridge, in an ecotone between the juniper zone on the ridge and the sage zone in the valley bottom. Seven flakes are present in an 18 meter by 8 meter area. No tools, diagnostic artifacts, or features are evident. Elevation is 6020'. An intermittent drainage between Squaw and Raven Ridges is located 400 meters southeast of the site.

42UN947 is a dispersed lithic scatter located in an area of low northwest-southeast trending ridges separated by deep drainages. Squaw Ridge is approximately 800 meters to the northeast. Most artifactual material is on a ridge top and south slope. A well-worn trough metate was found at the west site boundary. An estimate of 200 flakes, a biface tip, two cores, and a hammerstone fragment were inventoried in a 106 meter by 81 meter area. The site is characterized by presence of several small piles of flakes. The predominant lithic material is oolitic chert. No features or diagnostic artifacts were evident. One possible eroded pothole was located. Juniper, Western peppergrass, sage, composites, ephedra, and mountain mahogany grow on the site. Elevation is 5820'.

42UN950 is a small lithic scatter located at the south edge of a dune in the juniper zone. Approximately 55 flakes are present in the 36 meter by 12 meter area. Flakes are predominantly interior and secondary with a variety of cherts represented. One quartzite core was found. No features or diagnostic artifacts were observed, but a scatter of flat sandstone slabs approximately 15 meters northeast of the flake scatter may be a hearth. Several small piles of flakes are present, jeep tracks lead into the site, and vandalism in the form of surface collection is likely. Elevation is 5620'. A small drainage is located near the site.

42UN952 is a widely dispersed low density lithic scatter measuring 380 meters by 150 meters, with several hundred chert, quartzite, and obsidian flakes. One biface fragment, five slab metate fragments, and a hammerstone were observed. A flake concentration approximately 10 meters in diameter was found at the west edge of the site. Concentrations of fire-cracked rock and ash are present. No diagnostic artifacts or well-defined cultural features are evident. The site is located on a large dune vegetated with sparse juniper, Indian rice grass, greasewood, sagebrush, and saltbush. An unnamed spring of unknown permanence is situated 200 meters west. Site elevation is 5520'. A large intermittent drainage is located 200 meters east of the site.

42UN953 is a campsite located on a stabilized sand dune in a juniper forest. Most of the site lies within two adjacent blowout areas. Three hearths are present, with burned stone scatters; all have been vandalized. Artifacts include numerous chert and quartzite flakes, three mano fragments, one worked sandstone slab fragment, one metate in five fragments, and a core. Site dimensions are 24 meters by 46 meters. No diagnostic artifacts were found. Site elevation is 5640'. A large intermittent tributary to Powder Springs Wash is located less than 50 meters south.

42UN954 is an extensive campsite covering a 150 meter by 200 meter area, with at least 17 hearths composed of burned stone, ash, and burned bone. Several hundred chert, quartzite, and obsidian flakes were scattered over the site area, but few tools and no diagnostic chipped stone artifacts were observed. Many small flake concentrations are present. Approximately 15 Emery Gray corrugated and plainware sherds indicate a Fremont occupation. Historic trash and a recent sheep camp were found at the east edge of the site. Ground stone is notably absent. The site is located in the juniper zone but near the sage zone, approximately 100 meters east of a large intermittent tributary to Coyote Wash. Elevation is 6000'.

Sites with a Prehistoric Component and a Pre-1930 Historic Component

42UN921 includes three components: a prehistoric lithic scatter, an historic campsite dating to ca. 1900-1920, and a recent historic campsite (probable sheepherder's camp). Site area, 175 meters by 100 meters, was calculated for only the prehistoric and pre-1930 components. The lithic scatter is a dispersed scatter of flakes along a ridge top and at the east base of the sandstone bluff at the south end of the site. The scatter is densest on a low dune area demarcated by denser desert shrub vegetation: greasewood, hopsage, shadscale, sagebrush, grasses. A small flake concentration with a mano is located approximately 50 meters south of this dune area near the base of the bluff. Approximately 150 flakes are present, predominantly interior chert. One quartzite preform and two white chert projectile point fragments were observed. The absence of complete prehistoric diagnostics is undoubtedly related to historic use of the site. The oldest historic component overlies the north portion of the prehistoric component. It consists of a large scatter of at least 38 hole-in-the-top cans and 125 purple glass sherds. The recent camp, a concentration of wood fragments and condensed milk cans, is located 20 meters south of the old historic component.

No features were located, but an area of darkened soil was observed at the northeast corner of the bluff. Elevation is 5240'. Of interest is the orientation of the site due south, in full view and across a small drainage basin from 42UN920, a prehistoric rockshelter.

42UN924 is a large prehistoric campsite on the west slope of a low north-south trending ridge, approximately 30 meters west of the ridge top. A very sparse historic component consisting of one hole-in-the-top can and a mason jar lid is also present. Site dimensions are 106 meters by 140 meters. Six poorly defined hearth areas consisting of clusters of eroded oxidized sandstone are located 10 to 20 meters apart at the edges of small west-flowing drainages. Ashy soil was present in only one hearth. A sparse scatter of flakes extends across the rocky ridge slope. Flake concentrations approximately 2 meters in diameter were found at three of the six hearth areas. Approximately 60 flakes are present, mostly secondary, many heat-treated. Chert is the most frequently observed lithic material. One Desert Side Notched projectile point, one chert scraper, and one mano were located. Sparse juniper, grasses, sagebrush, hopsage, desert buckwheat, greasewood, and mountain mahogany grow on the site. Elevation is 5500'.

42UN925 includes a prehistoric lithic scatter and an historic campsite. Site dimensions are 30 meters by 27 meters. The lithic scatter is a localized concentration of mostly pumpkin chert interior flakes in a blowout area of a stabilized ridge top dune. An old east-west roadbed traverses the densest concentration, possibly indicating the presence of buried cultural material. Sixteen non-utilized flakes and one utilized flake are present. No diagnostic prehistoric artifacts or features are evident. The historic component consists of a scatter of hole-in-the-top cans and wood fragments at the south perimeter of the lithic scatter. Oxidized sandstone is found on top of the dune. Juniper, hopsage, grasses, sagebrush, and rabbitbrush grow on the site. A small drainage is located immediately to the west. Elevation is 5500'.

42UN938 is a dual component prehistoric lithic scatter and historic campsite located on a low dune formed on a tongue where two north-flowing drainages meet. The lithic scatter is extremely sparse and consists of a quartzite scraper, a chert projectile point tip, a mano fragment, and four flakes. No prehistoric features or diagnostic artifacts were observed. The historic component overlaps the north portion of the lithic scatter and consists of two hearths, a scatter of wood fragments, and enough trash to indicate a camp of fairly long duration. Historic artifacts point to a 1920s-30s occupation and include purple glass sherds, 26 hole-in-the-top cans, two white crockery fragments, one bucket, one water can, one mentholatum jar, one pepper can, one mother-of-pearl button, and a bullet casing (REM-UMC 25-35).

The site is in a protected area between two higher dunes, with a north view down the drainage. Small stands of juniper, rabbitbrush, prickly pear, greasewood, ephedra, and grasses comprise the plant community. Elevation is 5780'.

42UN948 is a very extensive, sparse scatter of lithics along the edge of a bench above a southwest-flowing drainage. The site encompasses the sage zone on the bench and the juniper zone on the drainage slope, an area 190 meters by 175 meters. Two components are present, an extensive prehistoric component of unknown period and cultural affiliation, and a pre-1920 historic component, possibly more recently used. The prehistoric component is composed of three piles of flakes, each approximately .5 meter in diameter, on the sage bench. The piles are approximately 15 meters apart and define the area of greatest artifact concentration. Historic trash is also densest in this area, and consists of clear glass sherds, hole-in-the-top cans, and brown crockery. The remainder of the site is an extremely sparse flake scatter extending in both directions along the sage-juniper ecotone. A second historic concentration consisting of a can and wood fragment scatter is located 100 meters west of the main concentration. No cultural features or diagnostic prehistoric artifacts were observed. Approximately 300 flakes are present. Oolitic chert interior flakes are most abundant, and several oolitic chert cores were found. The only tool observed was a quartzite biface tip. Site elevation is 5820'.

Historic Sites

42UN914 is a short-term historic campsite, probably a sheepherder's camp. It sits on a ridge top overlooking Coyote Wash 450 meters to the north. A scatter of cans of various types covers a 21 meter by 59 meter area. Presence of cans of post-World War I manufacture indicates a probable 1920s-30s occupation. Fifteen cans were found: one sardine, two tobacco, seven hole-in-the-top, four unidentified, one jelly bucket. A well-worn long-handled scrub brush and a wood-chopping log constitute the remainder of the site. No features were observed. The elevation of this desert shrub locale is 4880'.

42UN915 is a probable wild horse trap, difficult to date but probably no more recent than the 1950s and possibly older. It is situated in the bottom of a steep forked drainage, one end of which was blocked by a barbed wire fence. The other end is a narrow box canyon. Three barriers consisting of high beam fences and a loading chute are located at intervals along the drainage bottom. Side drainages and slopes are blocked by snow fence or logs. Bones from at least four horses litter the area near the barricade at the canyon head. Horses were apparently herded into the canyon at its widest point and driven to the area between barricades, where the loading chute is located. Site dimensions are 140 meters by 20 meters. Artifacts include one condensed milk can, one large bolt washer, one crown-top bottle cap and one soft drink can. Fossil turtle shell is present in poorly defined scatters along the canyon walls. The site, which is nearly barren of vegetation, is located at an elevation of 4800'.

42UN916 consists of a series of four low dry-laid masonry walls and alignments built at the south-facing openings of small rock alcoves. The largest alcove is 1 meter in depth and .75 meter in height, and the highest "wall" is two coursings in height (approximately 40 cm). The sandstone blocks have not been shaped. The easternmost alignment consists of one coursing of masonry in front of a small alcove. One meter west is a rock alignment 2 meters in length in front of a second irregularly shaped hole. A third alignment two coursings high is built in front of another hole ½ meter west. Three meters farther west, a fourth alignment, again two coursings high, is situated in front of a shallow overhang. This alignment has a corner at the west end. The site, which measures approximately 17 by 3 meters, overlooks the company town of Bonanza 700 meters to the southwest. The only artifacts present are a rusted hubcap, a T-joint pipe, a pop-top can, and two clear glass sherds. The artifacts are recent but the structures may be older. A sparse desert shrub plant community describes the vegetation. Site elevation is 5480'. A large intermittent drainage is located 500 meters to the west.

42UN922, a probable sheepherder's camp, consists of a scatter of cans and glass sherds on a knoll top immediately west of the Ouray-Bonanza road. The site, which covers a 55 meter by 40 meter area, affords an excellent 360° view. Most artifacts are of post-World War I manufacture, leading to the conclusion that the site was occupied during the 1920s or 1930s, or possibly even later. Wood fragments are scattered on the surface, and rock cairns are located southwest and south of the site. The artifact inventory includes 15 condensed milk, tobacco, and food cans, approximately 70 dark purple glass sherds, a leather boot part, two horseshoe fragments, a rusted buckle (for a sheep bell?), three gallon-size clear glass jars, cartridge shells, two hacksaw blade fragments, wire nails, and a mother-of-pearl button. Sparse sagebrush, cheatgrass, composites, saltbush, and other grasses grow on the site. Elevation is 5220'. Several large tributary drainages are located within 500 meters of the site, in all directions.

42UN927 is a short-term campsite located on the crest and south slope of a juniper-covered ridge top which commands an excellent south view of the White River canyons. The site consists of a concentration of approximately 30 soldered cans of various sizes and purple glass sherds, with recent trash from a later occupation scattered along the east portion of the ridge. No cultural features were evident, aside from roads along the ridge top. Artifacts indicate use and probably reuse of the site between 1900 and 1930. Elevation is 5780'. Intermittent drainages are located within 500 meters of the site.

42UN949 is an historic masonry structure located approximately 20 meters southwest of a long, fenced and covered gilsonite trench. This structure is the only historic structure observed during the project, and was recorded although it does not fall within a project sample unit. It is situated on a flattened area of the south

slope of a low ridge, immediately below a sandstone outcropping, and covers a 75 meter by 50 meter area. Amount and kinds of trash on the slope below the structure indicate long-duration, pre-World War I use. At least 200 hole-in-the-top cans of various sizes are present, along with crockery sherds, blue, purple, green, and brown patinated glass sherds, and ornamental iron stove parts.

Elaborate construction techniques, with beams and gabled ceiling and numerous south-facing doors and windows characterize the structure. The structure is a long rectangle divided into three rooms, with a fourth room to the north, partially excavated into the slope. A fireplace is located at the east end along with a rectangular can placed in the roof nearby for use with a woodburning stove and stove pipe. Exterior walls are coursed sandstone masonry with mortar. Interior walls are plastered. The roof is constructed with large beams and cross beams; vertical beams are placed centrally in the rooms for support. Lodgepole pine logs were laid at right angles to the longitudinal beams, and these are covered with juniper bark and sod.

Trash extends 60 meters south of the structure. Old roads lead to it from the west and south. A sandstone marker is placed at the right of the south road 40 meters south of the structure, and is inscribed "$\frac{5179}{BR}$".

Plaster is badly chipped off the interior walls, and the walls are covered with graffiti, the earliest of which is dated 1927. Portions of the roof of only two rooms remain intact.

The structure seems too elaborate and extensive to have been a habitation. However, Richard Dewey (personal communication), an American Gilsonite Company official, reports that it served as living quarters for prospectors when they were staking veins for American Gilsonite in the early 1900s. It was apparently abandoned before 1920.

A desert shrub community grows on the site. Sparse junipers are visible on nearby ridges. Elevation is 5740'. A large intermittent White River tributary is located 300 meters to the northeast.

42UN951 is a cluster of three pits, probably cooking pits, with an associated scatter of hole-in-the-top cans. The site is located in a stand of junipers in an area of low ridges and small intermittent drainages. The largest depression is circular, 2.5 meters in diameter. Two smaller depressions approximately 1 meter in diameter are located immediately north. Site dimensions are 10 meters by 5 meters. Burned stone and rock rubble is scattered around the pits; burned (sheep?) bone is also present. One flake was located 11 meters northwest of the pits. Elevation is 5520'.

Isolated Finds

The following table summarizes isolated finds and provides some indication of land use. More detailed information about each isolated find can be found in Appendix 3.

Table 7. Isolated find summary.

	Total		%	
Prehistoric	63		59.4	
non-utilized flakes/cores		27		42.9
utilized/retouched flakes		8		12.7
scrapers/bifaces/blades		8		12.7
projectile points*		12		19.1
manos*		7		11.1
hammerstones		1		1.6
*other flakes or tools may also have been present				
Historic	43		40.6	
hole-in-the-top cans		20		46.5
glass (includes purple sherds and whole bottles)		15		34.9
glass and cans		5		11.6
other: sheep bell		1		2.3
lantern		1		2.3
1-lb. coffee can		1		2.3

Material Culture

Several broad categories of artifacts found during the Seep Ridge Cultural Resource Survey are described below. Prehistoric artifact categories include chipped stone, ground stone, and ceramics. A variety of Euro-American artifacts were observed, but only glass artifacts are discussed here. Appendix 4 is a catalogue of collected artifacts.

Chipped Stone

Chipped stone artifacts constitute a large part of the entire prehistoric artifact inventory, as would be expected in an area with few sheltered sites and few sites of long occupation. Few tools were found in proportion to debitage. The most common lithic materials were, in order of frequency, oolitic chert, which outcrops on Raven and Squaw Ridges and occurs as pebbles and cobbles scattered over a broad band parallel to the ridges and extending two or three kilometers northeast and southwest of them; pumpkin chert, which outcrops on Blue Mountain in Colorado (Chandler and Nickens 1979b:99), northeast of the project area; and a variety of white and brown cherts encompassing a broad range of color and quality. The presence of oolitic chert on Raven Ridge undoubtedly added to its attractiveness to prehistoric populations.

Pumpkin chert turns brick red and shows evidence of crazing and potlid fractures when heated (Reed 1979); thermal alteration of this lithic material was common. Quartzite was seen far less frequently but a proportionately higher number of tools was made of this stone, which ranges in color from gray to light brown. Tiger chert, which occurs in southwestern Wyoming (Sharrock 1966:37), was observed infrequently, as was obsidian. The nearest documented obsidian sources are in Yellowstone National Park, in southwestern Utah (Breternitz 1970:163), and in central Colorado (Mark Stiger, personal communication). Chert cobble "fields" are found throughout the west project area on desert pavements very similar to those Sharrock (1966:134-136) describes in southwest Wyoming. These cobble fields were probably quarried to some extent. One quarry site in a chert cobble field has been recorded immediately north of the central project area (Larralde and Nickens 1980).

Projectile Points

Twenty-three projectile points with some diagnostic attributes were observed during the survey. Unfortunately, incompleteness, poor type definition, or extremely broad temporal range precludes the usefulness of nine of these artifacts as time or culture markers. The projectile points have been grouped into types on the basis of morphology, as follows:

Small side-notched points (Fig. 33a-f)

Number of specimens: 6

Description: These small projectile points are triangular in outline with straight (2) or slightly concave (4) bases.

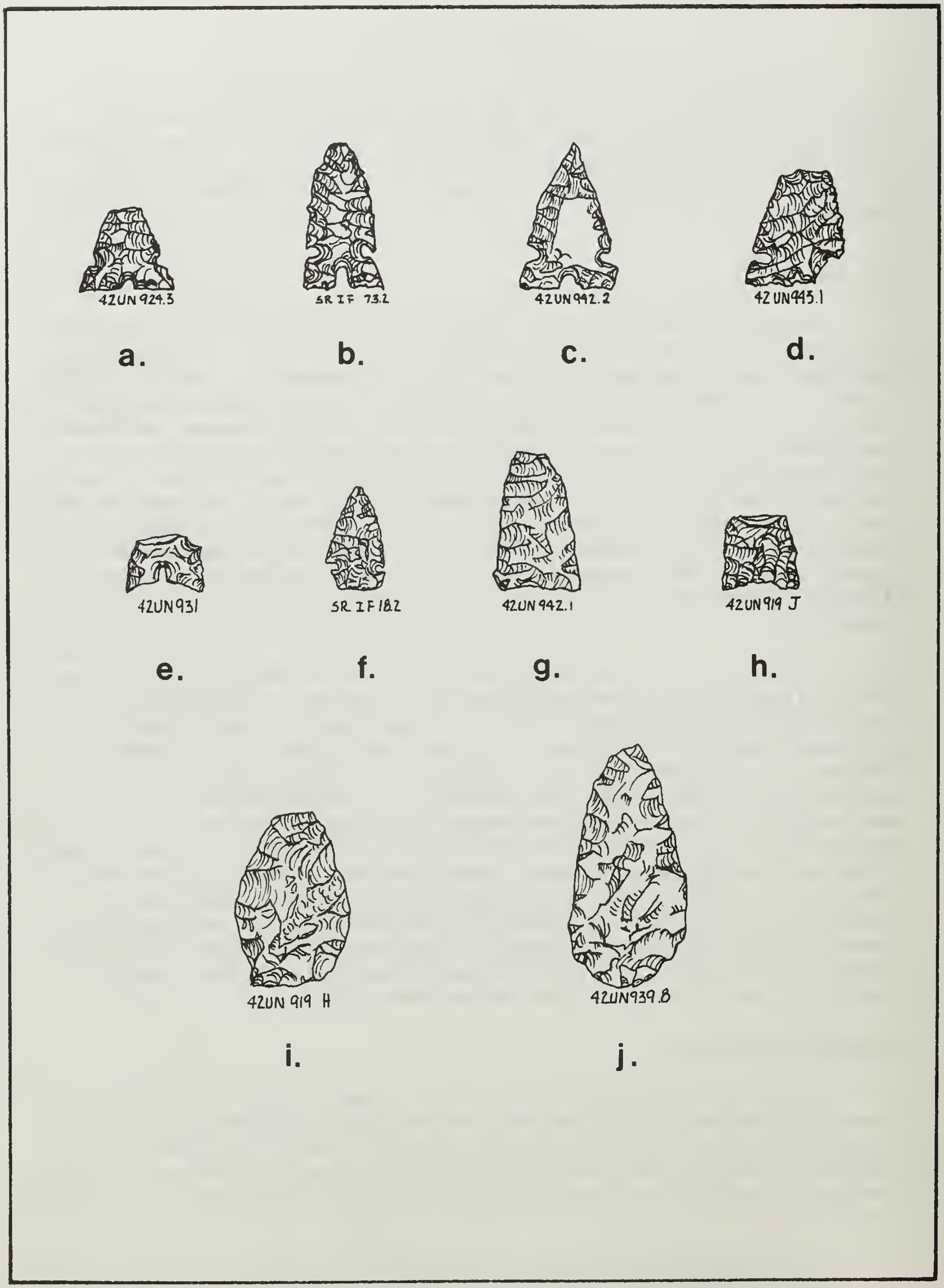


Figure 33. Projectile points. a-f: Desert Side Notched; g, h: Cottonwood Triangular; i, j: Medium Un-notched - possibly tool blanks.

Lateral edges are slightly excurvate. All but one are basally notched. Tips are fractured on three of the specimens. Cross-sections are lenticular (3) and plano-convex (3). Three of the points exhibit fine oblique parallel flaking.

Material: chert (5), quartzite (1)

Measurements (cm): length 1.8 - 2.8 (est), mean 2.3
width 1.0 - 1.7 (est), mean 1.4

Provenience: 42UN924, 42UN931, 42UN942, 42UN943; isolated finds 18 and 73, associated respectively with a large corner-notched point and a finely made pumpkin chert drill.

Comparisons: These projectile points are Desert Side Notched points, common in late prehistoric contexts (A.D. 1000 to historic times) throughout the Great Basin and the Colorado Plateau (Heizer and Hester 1978:10-11, Fig. 5d-i). In northeastern Utah, they indicate Fremont (Gunnerson 1969; Leach 1970) or Shoshonean (Frison 1970, 1973) occupation. Size indicates use as arrow points. This is the most common projectile point type found during the Seep Ridge survey. Other Desert Side Notched points found in northwestern Colorado and northeastern Utah have been described and illustrated as follows: Chandler and Nickens 1979a: 117-119, Fig. 8a-e, i-m; Chandler and Nickens 1979b:100-103, Fig. 8a-c, g; Type 1, Berry and Berry 1976: Fig. 6; Type 5a, Weber et al. 1977:164-166, Fig. 65; Type 2a, Anderson and Henss n.d.:105-105, Fig. 42; Types 4c and 43, Breternitz 1970:5, Fig. 2; Larralde and Nickens 1980:32, Fig. 11h.

Small un-notched points (Fig. 33g, h)

Number of specimens: 2

Description: The two points in the sample are triangular in outline with concave bases and slightly excurvate side edges. They are lenticular in cross-section. Tips are missing on both specimens.

Material: gray quartzite (1), brown chert (1)

Measurements (cm): length 2.2 - 2.6 (est), mean 2.4
width 1.2 -1.4, mean 1.3

Provenience: 42UN919, 42UN942

Comparisons: These points, which resemble Desert Side Notched points in all respects but notching, fit Heizer and Hester's (1978:11-12, Fig. 4g, h) description of Cottonwood Triangular points. They co-occur with Desert Side Notched points in late prehistoric contexts (A.D. 950-1620) and may in fact be blanks or unfinished Desert Side Notched points. Similar points have been reported from northwestern Colorado and northeastern Utah (Chandler and Nickens 1979a:134-135, Fig. 12a-c, f-h; Anderson and Henss n.d.:104-106, Fig. 42; Breternitz 1970; Leach 1966, 1970; Weber et al. 1977:147-149, Fig. 61), and are associated with Fremont or Shoshonean materials.

Medium un-notched points with convex or straight bases (Fig. 33i, j)

Number of specimens: 2

Description: These points are "leaf-shaped" with straight to convex bases and slightly excurvate lateral edges. Both exhibit oblique parallel flaking. One is complete, has a blunt tip, and is made from an interior flake with the ventral face merely retouched around the edges. The second has a ground base and a ground angular and pointed edge adjacent to the base, possibly indicating use in a haft. Cross-sections are lenticular and plano-convex, respectively.

Material: light brown quartzite (1), rose to white chalcedony (1)

Measurements (cm): length 3.6 - 4.1 (est), mean 3.85
width 1.9 - 2.0, mean 1.95

Provenience: 42UN919, 42UN939

Comparisons: This type, which occurs frequently in Dinosaur National Monument Fremont sites excavated by Breternitz (1970: type 1b), is similar to the preceding type not only in form but in the possibility that the tools may be unfinished, un-notched blanks for projectile points or they may be cutting tools. They are also similar to points or bifaces reported by Chandler and Nickens (1979a:133-135, Fig. 12c-h) and by Weber et al. (1977:178, Fig. 67c, d).

Medium corner-notched, straight to slightly concave base (Fig. 34a-c)

Number of specimens: 3

Description: Each of the points is fragmentary with missing tip. In a larger sample, they might be further segregated on the basis of depth of notching, notch angle, and shape of base. Here, they constitute a group more similar to each other than to other points found on the survey. Two are made from thin interior flakes and show little further shaping or reduction on the ventral side. One of these is one of the few oolitic chert tools observed during the survey, although oolitic chert was the most common debitage material on the Raven Ridge sites. It has parallel sides, a straight base, and asymmetrical corner notches. Another point is triangular in outline with shallow corner notches and a slightly concave base. The third, most fragmentary, is too incomplete to determine the outline; it has deep corner notches and a straight base. Cross-sections are plano-convex (2) and lenticular (1).

Material: oolitic chert (1), orange chert (1), light brown chert (1)

Measurements (cm): length - too fragmentary for measurement
width 1.8, mean 1.8

Provenience: 42UN941; isolated finds 26 and 54.

Comparisons: These points fall into the range described by Elko Corner Notched projectile points, an undiagnostic type with a temporal range from 6000 B.C. to A.D. 1350, possibly persisting to historic times (Holmer 1978). Breternitz (1970) classifies

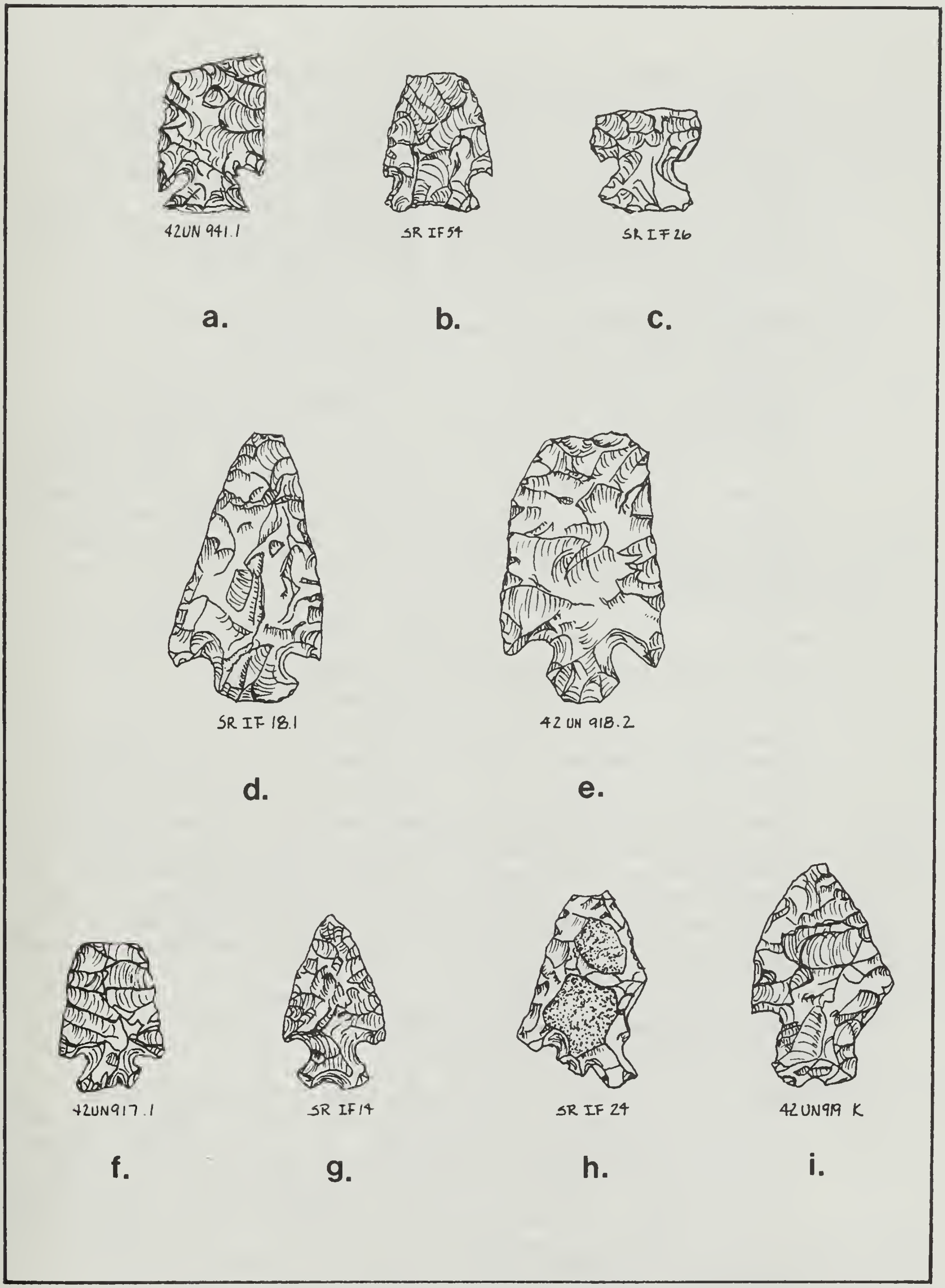


Figure 34. Projectile points. a-e: Elko Corner-Notched; f-i: Pinto/Duncan-Hanna.

them as types 2B, 3A, and 3E. Many of Sharrock's (1966) "unclassified" points are similar. The points resemble Berry and Berry's (1976:16, Figs. 8, 9) types VI, VII, and IX, thought to be atlatl (Archaic) points, also undiagnostic. Weber et al. report similar points (1977: Types 4c and 43, Figs. 63, 64), as do Anderson and Henss (n.d.: Type 3, Fig. 42), Simms (1979:11), and Larralde and Nickens (1980:32, Fig. 11f). Hauck et al. (1979: Figs. 13, 3b) place these points in a Late Plains Archaic framework (ca. 3000 to 1500 B.P.).

Large corner-notched points, convex base (Fig. 34d, e)

Number of specimens: 2

Description: These points are separated from the previously described points on the basis of size and convexity of base. One point is triangular in outline with rounded corner notches and a slightly convex base; the tip is missing. The second is asymmetrical, excurvate on one edge and straight on the other, with a broken, reworked end and a heavily ground base. The end and the lateral edges show heavy utilization. The tool may have functioned as a hafted cutting tool following its use as a projectile point.

Material: rose/brown quartzite (1), light brown siltstone (1)

Measurements (cm): length 4.5 - 4.9 (est), mean 4.7
width 2.7 - 2.8, mean 2.75

Provenience: Isolated find 18 (in association with a very small Desert Side Notched projectile point, Figure 33f); 42UN918.

Comparisons: Although easily separated by size in this group, these points are similar to those of the preceding type and also fall into the range for Elko Corner-Notched projectile points. Comparisons are duplicate. The point from 42UN918 closely resembles Weber et al.'s (1977:160-161, Fig. 63L) type 4d, for which no cultural affiliation was suggested. The base of this point is unusual in the depth of notching, resulting in a stem-like protrusion.

Medium stemmed, indented base points (Fig. 34f-i)

Number of specimens: 4

Description: Three of these projectile points are biconvex in cross-section; one is plano-convex. All are triangular in outline with slightly expanding edges. All have shoulders approximately at right angles to the stem and all have basal notches. Fine diagonal collateral flaking is characteristic. Size varies considerably. The largest shows reworking of the shoulder edges.

Material: heat-treated pumpkin chert (1), brown to light gray chert (3)

Measurements (cm): length 2.9 - 3.7 (est), mean 3.4
width 1.7 - 2.5 (est), mean 2.1

Provenience: 42UN917, 42UN919; isolated finds 14 and 24.

Comparisons: These points resemble the Pinto series of the Great Basin (Heizer and Hester 1978:3-5, Fig. 2a-f; Holmer 1978:11, Fig. 5i), dating at 8300-6200 B.C., and the Duncan/Hanna series of the Great Plains (Wheeler 1954). They are distinguishable from the Elko Series by the well-defined stem and deep basal notching; however, possible overlap may be seen in the point from 42UN917 and in isolated find 24. Chandler and Nickens (1979a:128-129, Fig. 10f, g) describe similar points as Elko Eared. Hauck et al. (1979: Figs. 1, 2) refer to them as Duncan Points (McKean complex), Middle Plains Archaic, 5000-2500 B.P. (Frison 1978:83). Morphologically similar but smaller points were reported by Weber et al. (1977:150-152, Fig. 62a, b). The largest Seep Ridge point resembles Sharrock's (1966:56, Fig. 38) Duncan points.

Un-notched concave base point (Fig. 35a)

Number of specimens: 1

Description: This point is lenticular in cross-section with slight evidence of a shallow flute on both sides. Lateral edges are expanding; the upper portion is missing. The base is slightly concave and slightly ground.

Material: gray quartzite with tiny black inclusions

Measurements (cm): length - too fragmentary to determine
width 2.1

Provenience: Isolated find 56, found with a fragment of a bifacially flaked tool.

Comparisons: This point resembles McKean Lanceolate Plains projectile points (Holmer 1978) and the Black Rock Concave Base points of the Great Basin (Aikens 1970, Heizer and Hester 1978). These types date respectively at ca. 2850 to 1750 B.C. (Holmer 1978) and 5850-1250 B.C. or 650 at Hogup Cave (Aikens 1970). Similar points have been found in the Bonanza Power Plant site immediately north of the project area (Chandler and Nickens 1979b:114, Fig. 10b) and in northwestern Colorado (Chandler and Nickens 1979a:135-136, Fig. 12e). The point base bears some likeness to Paleo-Indian concave base lanceolate points of the James Allen, Lusk, and Frederick varieties as well as to other less well-known early point types (Frison 1978:34, Figs. 2.3, 2.4e, f, 2.5d; Gooding 1979: Figs. 37, 45).

Stemmed, shouldered lanceolate point (Fig. 35b)

Number of specimens: 1

Description: The point is lenticular in cross-section, with a long stem and slight shoulders sloping upwards (distally). The base is broken and missing, but would be slightly convex in outline if present. The tip has been broken and reworked extensively so that the point is asymmetrical and may have been used most recently as

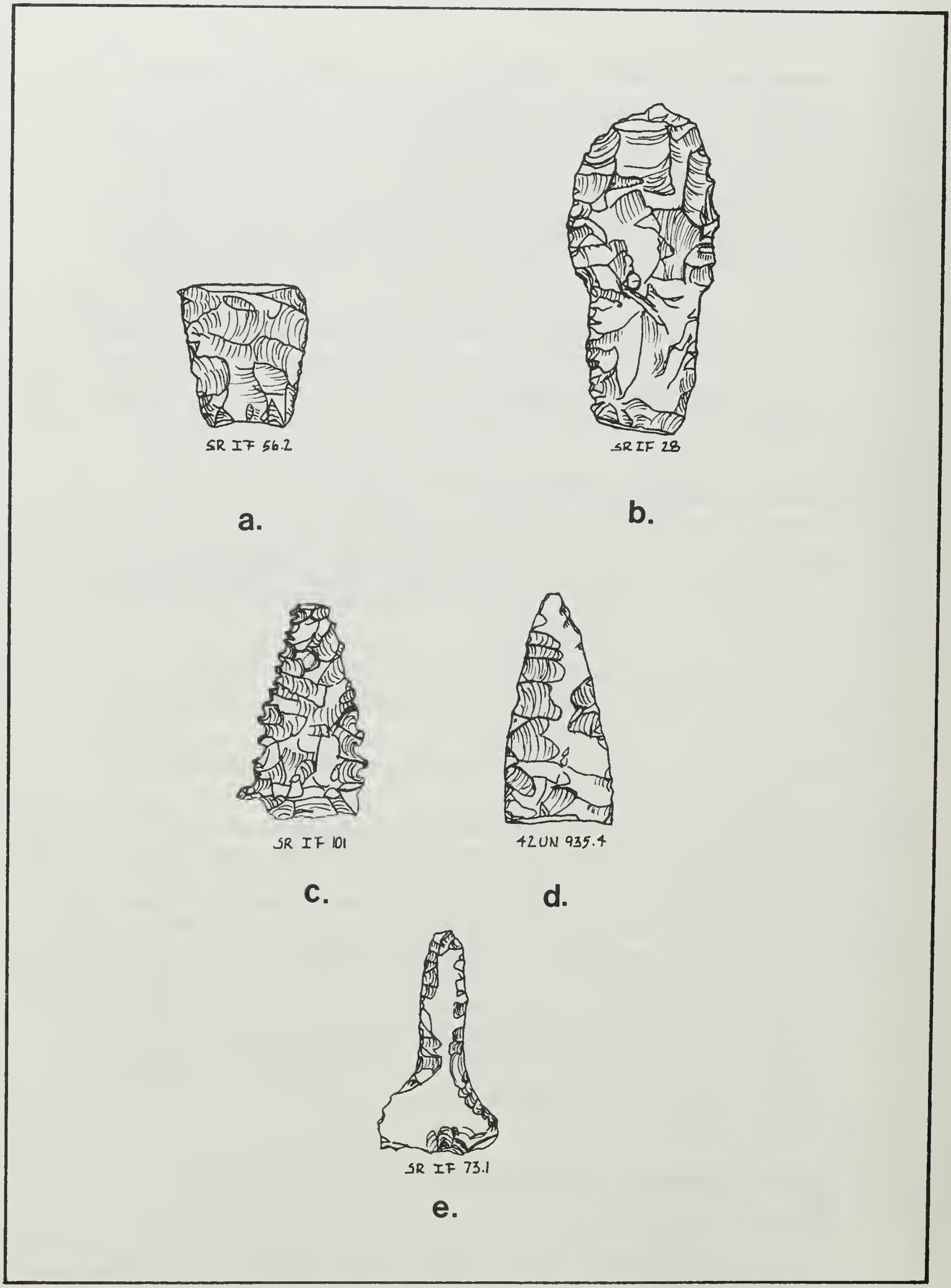


Figure 35. Projectile points and drill. a: McKean Lanceolate or Black Rock Concave Base; b: Hell Gap; c, d: unidentified; e: drill found with the Desert Side-Notched point shown as Figure 32b.

a hafted cutting tool. Flaking is diagonal collateral. Large scars and fractures mark the break on the distal end. Stem edges are heavily ground.

Material: light brown chert

Measurements (cm): length 5.5
width 2.6

Provenience: Isolated find 28

Comparisons: The point resembles Wormington's (1957) Figure 57 from the Lind Coulee Site in Washington, dating at 8700 ± 400 B.P. It also shows marked similarities to Renaud's (1942) Subtype I Rio Grande point, tentatively dated at 6000-7000 B.P., which in turn resembles Agate Basin, Hell Gap, and Lake Mohave types (Black 1980; Honea 1965, 1969). The Seep Ridge point is visually very like a Rio Grande point found in the southern Rocky Mountains (Black, Horvath, and Baker 1980: Fig. 30), down to distal flake scars and reworking and to the asymmetry of the distal end of the blade. The point also falls within the size range for Hell Gap points as defined by Frison (1974) at the Casper Site in Wyoming, with a date of 10,000 B.P. Frison believes the large size range for Hell Gap points to be a function of the amount of reworking necessary to resharpen them into projectile points after impact breakage, rather than into cutting tools. However, the asymmetry of the Seep Ridge blade may indicate that it was specifically resharpened to function as a cutting tool. The point is ground all along the stem edges to the widest point of the shoulders suggesting a deeply socketed haft. Flake scars at the distal end may have resulted from the same kind of forceful impacts Frison describes for his Hell Gap sample.

Problematical points, bases missing (Fig. 35c, d)

Number of specimens: 2

Descriptions: IF 101 is a long triangular projectile point with deeply serrated edges and parallel oblique flaking. Some indications of corner notching are present. Both tip and base are missing. The point is lenticular in cross-section. The tip from 42UN935 is very thin in lenticular cross-section and exhibits delicate parallel flaking. Most of the surface is covered with white patina. Flake scars with no patina are present on opposite sides and opposite edges, perhaps indicating that the tool was collected and brought to a site of more recent date where it was resharpened. The base and a small portion of the tip are missing, making it impossible to determine the original form. The patina does not react with hydrochloric acid and apparently does not have a calcium base.

Material: Respectively, pumpkin chert, and fine, light brown chert

Measurements (cm, of portions present): length 3.7, 3.9
width 2.0, 1.8

Provenience: Isolated find 101; 42UN935

Comparisons: IF 101 fits the size range for Elko Corner Notched projectile points, previously described as having too broad a geographic and temporal range to be diagnostic. Serrated edges are unusual but not unknown in the area; an Elko Eared point with serrated edges is illustrated by Larralde and Nickens (1980: Fig. 11g).

The tip from 42UN935 is too fragmentary for speculation as to its cultural affiliation based on morphology. However, the fine flaking pattern and careful manufacture suggest the Paleo-Indian tradition.

Bifaces, Scrapers and Blades

Fragmentary bifacially and unifacially flaked tools were common in the project area, but complete tools were rare. Consequently no morphological types for either bifaces or scrapers can be described. A total of 32 retouched and utilized flakes serving cutting or scraping functions as surmised from wear are present in site and isolated find artifact inventories. As mentioned above, some tools which have been described as projectile points may in fact be cutting or scraping tools.

Three large blades were collected (Fig. 36a-c) and are described below; all are lenticular in cross-section. Materials vary from coarse-grained white quartzite to very fine-grained gray quartzite to a highly silicified brown chert. IF 19, potentially the largest although the base is missing, is triangular in outline with excurvate lateral edges and shows no apparent wear and very little retouch. Three large diagonal fractures or spall lines are evident on one face and may indicate an inherent weakness in the material that caused breakage during the tool-blank stage of manufacture. IF 88 was found in a high site density area on the northeast slope of Raven Ridge. It is an extremely long narrow blade with a convex base, irregular in lateral outline, with a collateral flaking pattern. Small scars resembling pecking or battering scars and small step fractures are evident on both faces. A large knob of unreduced material is situated at the midsection of the ventral face (see cross-section, Fig. 35b). The blade from 42UN919 is asymmetrical in outline with one lateral edge markedly more convex than the other. The base is broken and missing but the portion present is constricted and the remainder apparently extended below the used blade edges. Flaking is random. A small portion of cortex remains on the distal end, which appears to have been broken and reworked. Both edges show bifacial attrition. This implement may have been a hafted cutting tool. Similar blades to the above three are reported by Anderson and Henss (1978:109-113, Fig. 43), Weber et al. (1977:174-179, Figs. 67, 68), and Breternitz (1970: types a and b).

Drill

One drill (Fig. 35e) was found in association with a Desert Side Notched projectile point, isolated find 73. The drill is lenticular in cross-section. The base is notched, but the two tangs are missing. The drill is pumpkin chert. Its dimensions are: length 3.8 cm; basal width

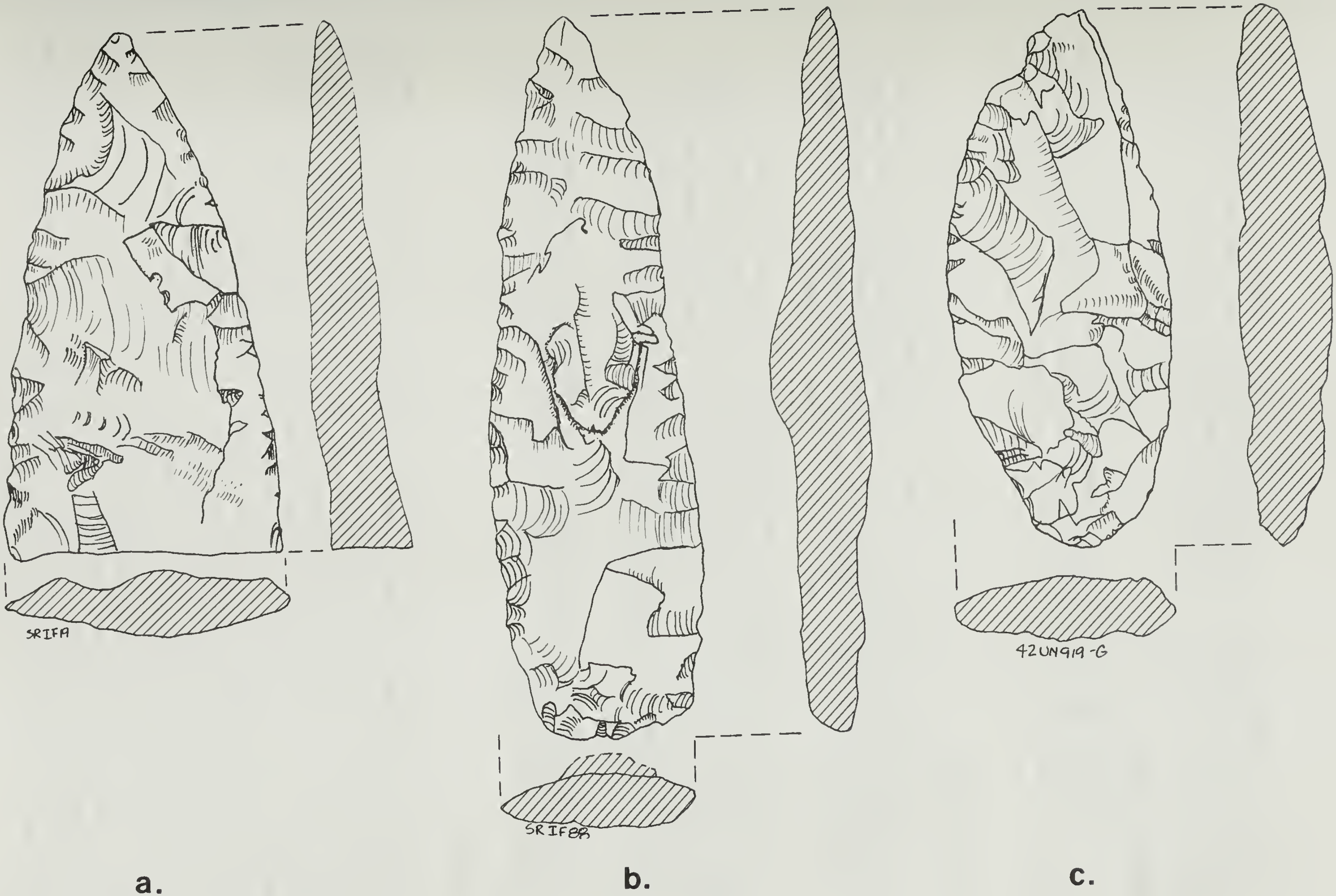


Figure 36. Blades. a: IF 19; b: IF 88; c: 42UN919G.

1.9 cm; bit width .6 cm; bit thickness .3 cm. A Fremont or Shoshonean cultural affiliation is assumed through association with the projectile point. Similar drills are reported by Chandler and Nickens (1979b:123-124, Fig. 16) and Breternitz (1970: Type 1 drills).

Battered Stone

Hammerstones in the form of unmodified chert cobbles with battering scars on their periphery were found at six sites and as one isolated find. These are thought to have been used as percussors in core reduction and for other battering and hammering activities.

Ground Stone

Ground stone was common throughout the project area. It was found at 16 sites and seven isolated locales. The distribution seems to be ubiquitous and no inferences as to environmental factors influencing ground stone location are advanced. One trend is noteworthy, however: the presence of isolated manos near the banks of arroyos.

Forty-two manos and mano fragments were observed. Thirty-nine were of the ovoid handstone variety and three were subrectangular. None were large enough to be used with both hands. Pecking and shaping of peripheral surfaces were frequently observed, along with bifacial and occasionally end wear. Red quartzitic sandstone cobbles, common in alluvial gravels in streambeds and on desert pavements, were easily obtainable raw materials.

Nineteen metates and numerous metate fragments were observed, including one basin metate and one trough metate. The remainder were sandstone slab metates.

Ceramics

Ceramics were found at two sites, 42UN931 and 42UN954, both large campsites. At 42UN931, five "corrugated" sherds were present; at 42UN954, 15 "corrugated" and plain grayware sherds were present. All fit the type description for Emery Gray, the dominant type in the San Rafael Fremont area, dating at A.D. 700-1200 (Madsen 1977:31-33). Emery Gray is differentiated from Uinta Gray mainly by the tempering material: Uinta Gray is tempered with white calcite particles that react with hydrochloric acid; Emery Gray is tempered with basalt, quartz, and sometimes mica. The northern limits of the range of Emery Gray are approximately 60 miles south of the project area (Madsen 1977:31). The presence of Emery Gray in the Uinta Basin is not unusual, however; it has been documented by Breternitz (1970) and by Larralde and Nickens (1980) in Utah, and by Weber et al. (1977) in northwestern Colorado. It is occasionally found with Uinta Gray, for example at the Turner-Look site at the south edge of the Bookcliffs (Madsen 1977:32). The range for the two types seems to overlap more than Madsen indicates. In addition, Shoshonean ceramics have been found in the Uinta Basin, along with an occasional Anasazi sherd.

Of the sherds from 42UN931 (Fig. 37), three are "punched" with a stick or some other implement, forming regular indentations on the exterior; three exteriors are scraped and one is polished. One is decorated with parallel incising perpendicular to the rim. All interior surfaces are scraped. At least three vessels appear to be represented, judging from profile and surface treatment differences in the three jar rim sherds, although all have everted rims. Paste is light to medium gray; core is dark gray to black; temper consists of finely crushed igneous rock and core texture is fine. Thickness ranges from 5 to 8 mm.

Euro-American Artifacts

Historic artifacts consist predominantly of hole-in-the-top cans, i.e. cans manufactured prior to 1920 with a soldered circular cut in the top through which food was forced, and purple glass bottle sherds, manufactured prior to 1915 (Gillio, Levine, and Scott 1980). A variety of horse gear fragments; tobacco, condensed milk, and other kinds of cans; crockery fragments; shoe parts; buttons; bottles and jars; a lantern; and a sheep bell were also observed.

Glass fragments with neck portions or traceable trademarks are diagnostic to some extent by manufacturing technique and glass company history. Table 8 and Figures 38 to 43 summarize datable characteristics of glass found during the Seep Ridge Cultural Inventory. It seems that most glass bottles in use during this period in the project area held condiments, liquor, or medicine. Discrepancies occur between some trademark dates and the date that manufacture of purple glass was discontinued, e.g. some purple bottles have 1920s trademarks when purple glass supposedly was no longer made after ca. 1915. Apparently, some glass companies were slower to discontinue adding manganese to glass than others, resulting in a range of dates for this attribute (Douglas Scott, personal communication).

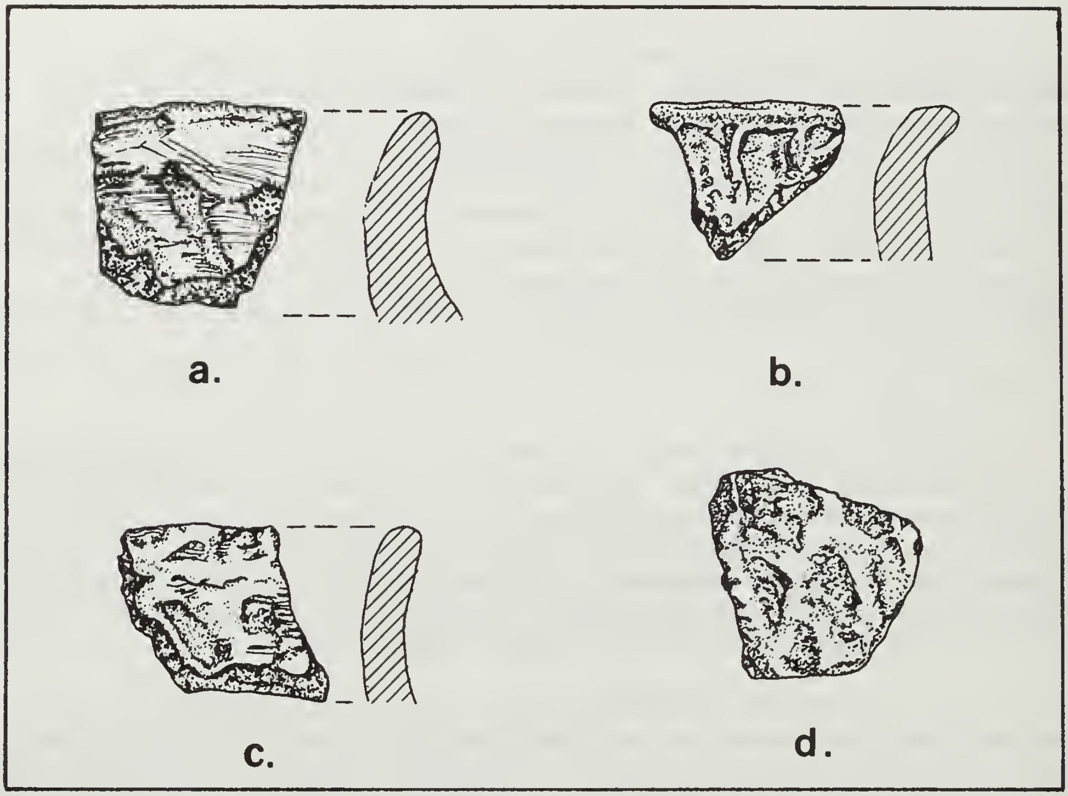


Figure 37. Sample of four Emery Gray "punched" sherds collected from 42UN931. a, b & c are rim sherds. b is incised.

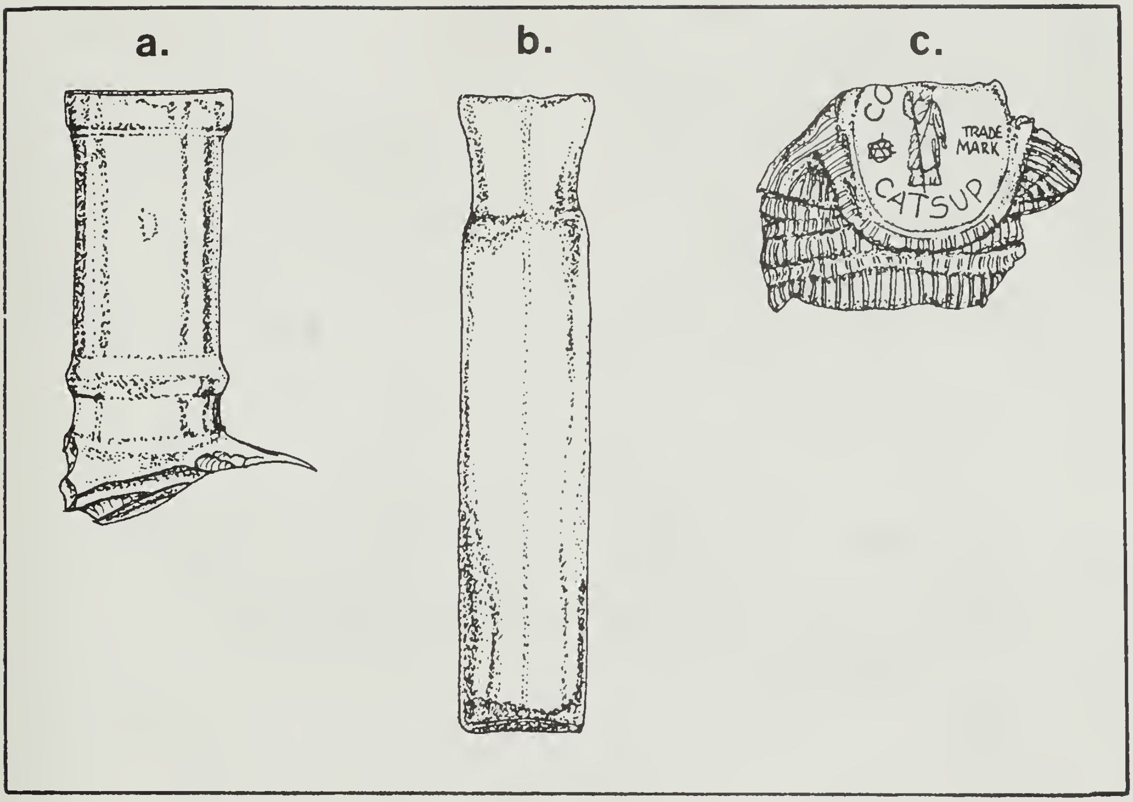


Figure 38. Historic artifacts. a: IF 2, neck of a "panel" bottle of the kind used to hold patent medicines. Putnam (1965) refers to the lip finish as a "packer or extract lip." b: IF 49, aqua glass vial similar to "homeopathic tube vials" illustrated in the 1910 Illinois Glass Company catalog (Putnam 1965). c: Columbia catsup bottle screw-on cap.

Table 8. Diagnostic characteristics of glass artifacts found during the Seep Ridge Cultural Inventory.

IF 2, bottle neck (Fig. 38a)

Characteristics: seam to ring more than ¼" below rim

Glass color: purple

Date: 1881-1903; semi-automatic bottle machine

Remarks: Appears to be a "panel" bottle of the kind used for patent medicines. Lip finish is referred to as "packer or extract" lip in the 1910 Illinois Glass Company catalog (Putnam 1965).

IF 3, insulator lip?

Characteristics: molded edge

Glass color: purple

Date: pre-1915

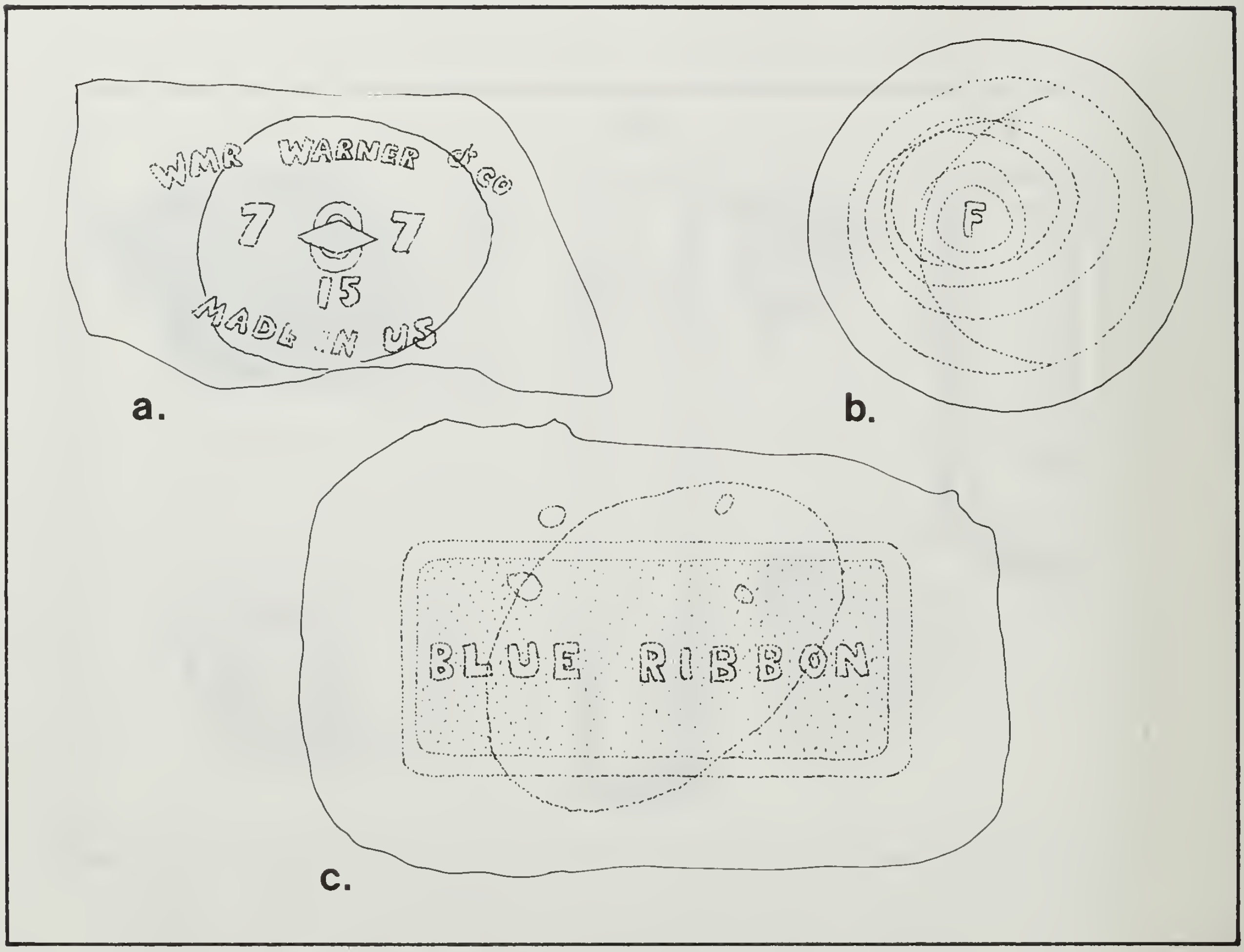


Figure 39. a: IF 5, bottle bottom; b: IF 71, bottle bottom; c: from 42UN927, bottle bottom. Artifacts and trademarks are actual size.

Table 8, continued

IF 5, bottle neck and base (Fig. 39a)

Characteristics: threaded neck with metal screw-on cap; seam to lip

Glass color: aqua

Date: aqua glass manufacture dates: 1880-1920 (Gillio, Levine, and Scott 1980)

Remarks: Initials same as WRN & Co. dated by Toulouse (1971:543) at ca. 1880 to 1910; diamond portion of trademark is similar to Owens Glass Co. trademark, which would date the bottle at 1937 or 1947 (Toulouse 1971:403).

IF 7, bottle bottom (Fig. 40a)

Characteristics: seam around base, concave base, bubbles in glass

Glass color: purple

Date: pre-1915

Remarks: Trademark not found in Toulouse (1971)

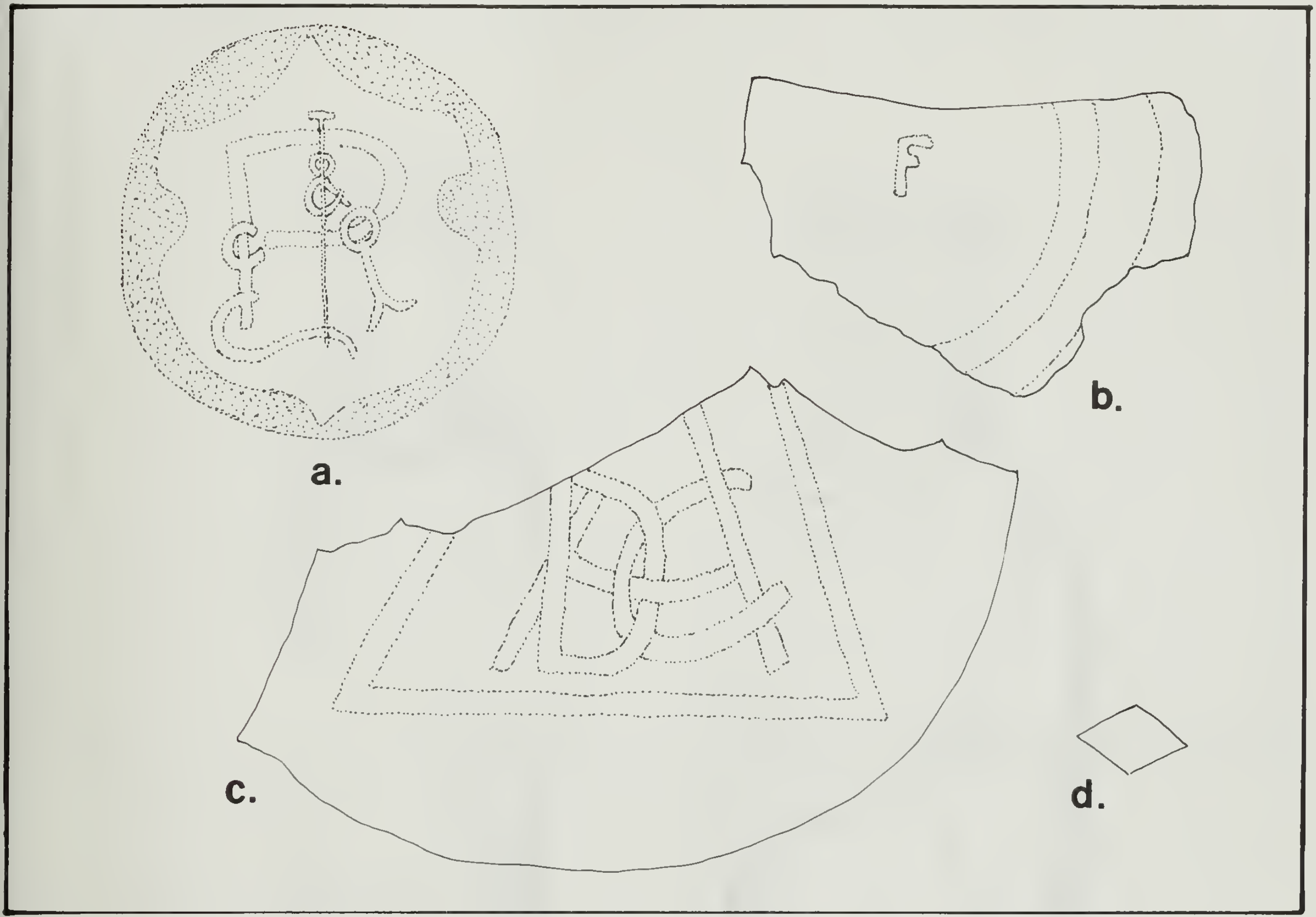


Figure 40. a: IF 7, bottle bottom; b: IF 12, bottle bottom; c: IF 22, bottle side; d: IF 22, bottle bottom. Artifacts and trademarks are actual size.

Table 8, continued

IF 9, broken bottle (Fig. 41)

Characteristics: no seam, shallow well in lip, bubbles and striations in glass

Glass color: deep purple

Date: 1800s-1900

Remarks: Putnam (1965) refers to lip as "bead finish." Shape is similar to "Elixir" bottles illustrated in 1910 Illinois Glass Company catalog.

IF 12, bottle bottom (Fig. 40b)

Characteristics: seam around base

Glass color: purple

Date: pre-1915

Remarks: Trademark similar to that of Wm. Frank & Co., Pittsburgh, Pa., 1866-1904 (tentative dates) according to Toulouse (1971:193) or to a modern mark by a German glass company (1971:189-190).

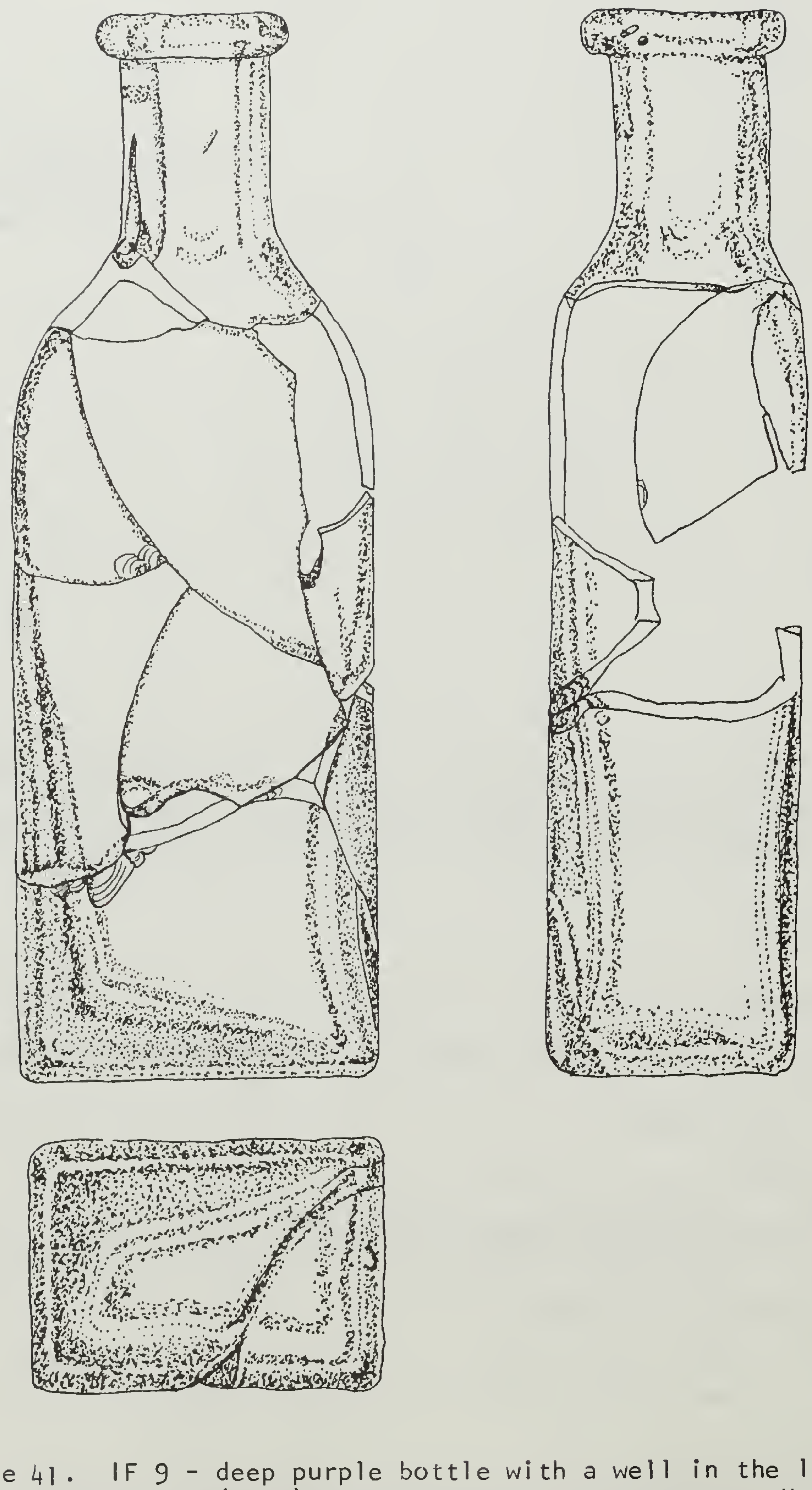


Figure 41. IF 9 - deep purple bottle with a well in the lip. Putnam (1965) refers to the lip finish as a "bead finish." Shape is similar to "Elixir" bottles illustrated in the 1910 Illinois Glass Company catalog.

Figure 42. IF 32 , vaseline jar and base, actual size.

Table 8, continued

<u>IF 22, broken bottle</u> (Fig. 40c, d)

Characteristics: "brandy" or liquor bottle neck finish

Glass color: purple

Date: pre-1915

Remarks: Trademark is post-1924 Diamond Glass Company, Royersford, Pa. (Toulouse 1971:550). Mark on bottle side was not identified.

<u>IF 32, Vaseline jar</u> (Fig. 42)

Characteristics: threaded lip, seam around base and up side to threads, bubbles in glass, concave base

Glass color: purple

Date: pre-1915

<u>IF 41, bottle neck</u>

Characteristics: ring below, lip "packer or extract"

Glass color: purple

Date: pre-1915

Remarks: Similar in style to pickle or condiment bottle styles illustrated in Illinois Glass Co. 1910 catalog.

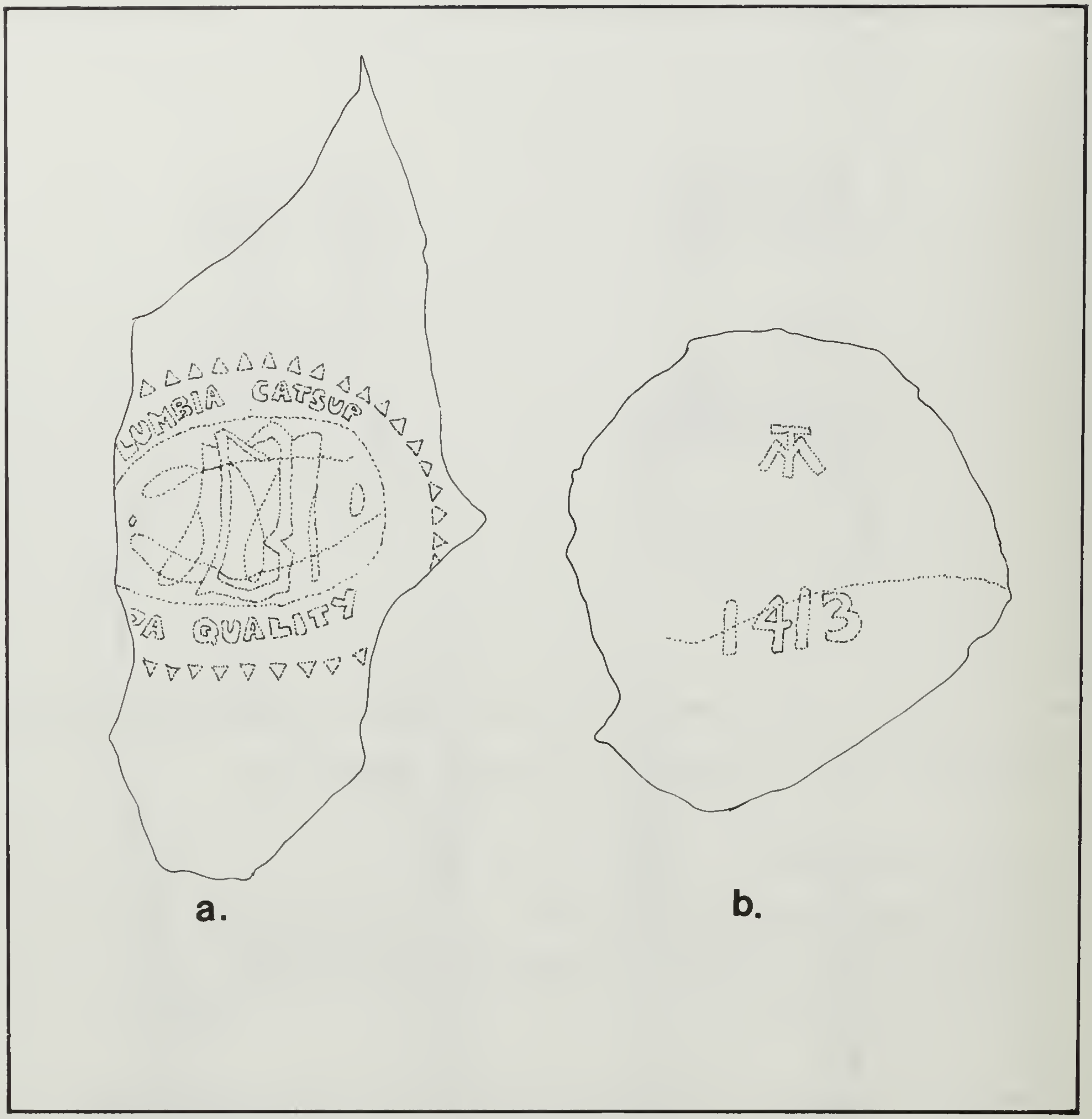


Figure 43. Side and base of Columbia catsup bottle from 42UN921, actual size. Catsup bottle cap is illustrated in Figure 38(c).

Table 8, continued

IF 43, necks of two bottles

Characteristics: 1) "extract or packer" finish lip with ring below lip on neck and rounded shoulder with flat front and back; 2) brandy or liquor bottle neck and lip

Glass color: purple

Date: pre-1915

Remarks: 1) Shoulder is similar to ball neck panel bottle in Illinois Glass Co. 1910 catalog, a type used both for patent medicines and for pickles or condiments.

Table 8, continued

<u>IF 49, vial</u> (Fig. 38b)

Characteristics: seam to lip, bubbles in glass, made for use with cork or stopper

Glass color: aqua

Date: dates for aqua glass: 1880-1920 (Gillio, Levine, and Scott 1980), post-1903 - seam to lip (automatic bottle machine)

Remarks: Similar to "homeopathic tube vials" illustrated in Illinois Glass Co. 1910 catalog (Putnam 1965:120-121).

<u>IF 61, bottle body sherds</u>

Characteristics: molded scalloped trim

Glass color: purple

Date: pre-1915

Remarks: Similar to catsup bottle molding illustrated in Illinois Glass Co. catalog (Putnam 1965:194).

<u>IF 71, bottle</u> (Fig. 39b)

Characteristics: crown top, concave base

Glass color: purple

Date: 1907-1915

Remarks: Probably a soda or mineral water bottle (Putnam 1965:241). Crown tops were introduced in 1892 and were in general use by 1907 (Gillio, Levine, and Scott 1980:17).

<u>42UN921, bottles</u> (Figs. 38c; 43a, b)

Characteristics: 1) metal screw cap located - "Columbia Catsup;" scalloped molding on bottle bottoms, bubbles in glass; 2) brandy or liquor bottle neck

Glass color: purple

Date: pre-1915

Remarks: Toulouse (1971:496) found the bottle base trademark on an amber export beer bottle dating at ca. 1880-1910; the mark does not correspond to any known glassmaker. The trademark on the bottle body could not be identified. The base molding resembles that on other pickle, preserve, and condiment bottles illustrated by Putnam (1965).

<u>42UN927, bottle base</u> (Fig. 39c)

Characteristics: concave

Glass color: aqua

Date: aqua glass dates to ca. 1880-1920

Remarks: The trademark dates at ca. 1920-30 and identifies the bottle as a prescription bottle made by Standard Glass Co., Marion, Indiana (Toulouse 1971:87-89).

CHAPTER 4

SEEP RIDGE CULTURAL INVENTORY DATA ANALYSIS

This chapter includes a brief account of regional prehistory and history, an analysis of settlement patterns in the project area, and the development of sensitivity zones based on these perceived settlement patterns. An assessment of resources available in the study tract concludes the chapter.

Regional Prehistory

Since Berry and Berry (1976) and Chandler and Nickens (1979a) have already summarized in detail previous archaeological work in the area, that summary will not be repeated here. What follows is a brief outline of area chronology as currently understood so that the ensuing discussion of settlement patterns can be seen in diachronic perspective. Three surveys not included in the above reports should be mentioned. The first is a linear survey of a pipeline for the Riverbend gathering system (Simms 1979) which traversed the Seep Ridge Project area; the second is a sample-oriented survey of BLM lands immediately south of Dinosaur National Monument (Holmer 1979). On both of these surveys, few diagnostic artifacts were found and sand dune sites, presumably Archaic in cultural affiliation, were recorded. The third survey is a sample-oriented survey of Moon Lake railroad, water, and transmission line corridors that cross the Seep Ridge tract (Reed 1980a, b). The three sites located cluster in the juniper areas near Raven and Squaw Ridges. Fremont ceramics were found on two sites, one of which is adjacent to but not within Seep Ridge boundaries.

Paleo-Indian Tradition

Evidence is mounting for Paleo-Indian occupation of the Uintah Basin. These hunters subsisted primarily on now-extinct megafauna. The undated bottom levels of Deluge Shelter in Dinosaur National Monument, which provides the longest stratigraphic sequence for the Uintah Basin, suggest dates of ca. 8000 B.C. (Leach 1970:205). The period is well-represented elsewhere in the Basin and in northwestern Colorado by isolated artifacts. Clovis points of the Llano Complex (ca. 10,000 B.C. - 9000 B.C.) and points of the Folsom Complex (ca. 9000 B.C. - 7000 B.C.) have been reported from northwestern Colorado and Dinosaur National Monument. Alberta, Scottsbluff, and Hell Gap points (ca. 8000 B.C.) have been found to the north, east, and immediate west and southwest of the project area (Hauck et al. 1979; Weber et al. 1977:19-20; Leach 1970:205; Larralde and Nickens 1980). These points indicate affiliations with the Great Plains.

A Hell Gap point was found during this survey on a rocky barren stream terrace in the central Seep Ridge project area and is described in Chapter 3.

The Archaic Tradition

The focus of much recent controversy, this tradition has been defined by a hunting and gathering lifestyle dependent on plant resources and small game. As a lifestyle, it persists to historic times in the Great Basin. As a culture period, it spans the time from the end of the paleolithic period at ca. 5500-6000 B.C. to the inception of Fremont agriculture at ca. A.D. 600.

The extended Archaic occupation of northwestern Colorado and northeastern Utah has been well documented. Archaic components are present at several excavated sites in Dinosaur National Monument (Breternitz 1970), with dated occupations at Thorne Cave (Day 1964) and Deluge Shelter (Leach 1970). Hauck et al. (1979) report evidence for Early, Middle, and Late Plains Archaic activity in the Natural Buttes area; most diagnostic artifacts found during that survey are of Middle Plains Archaic age (ca. 2550 B.C. - 550 B.C.). McKean points from this period have also been reported (Berry and Berry 1976:31; Sisson 1978:158), along with two other probable Archaic projectile point bases (Weber et al. 1977:20).

Suggested periods of heavy Archaic use at Deluge Shelter (Leach 1970) and Sudden Shelter (Jennings et al. 1980) agree with the Natural Buttes Study's survey evidence for heaviest occupation (Hauck et al. 1979). Site density is generally higher during this period (ca. 3000 B.C. - 500 B.C.) on the northwestern Plains (Frison 1978).

A McKean or Black Rock Concave Base projectile point from the Seep Ridge project points to early Archaic (or possibly Paleo-Indian) occupation. Two Elko Series points of possible Archaic affiliation were also located, as well as three smaller points of similar form.

As has been frequently suggested, it is likely that many recorded lithic scatters with no diagnostic artifacts are Archaic. Many such sites have large amounts of ground stone. Their location on sand dunes suggests seed processing.

Fremont

A change in subsistence patterns occurs at ca. A.D. 300 with the technological shift from atlatl and dart to bow and arrow. Uinta Gray ceramics and corn agriculture appear soon afterwards, demarcating the Fremont peoples from those living in the Basin before and after them. Fremont village sites have been found in and near Dinosaur National Monument. As Marwitt (1970) has summarized, these sites are situated on low ridges and knolls above arable floodplains. Others (Madsen 1979) have postulated that Fremont peoples in northeastern Utah were more dependent than other Fremont groups on wild plant and game resources.

The Uintah Fremont occupied the Uintah Basin and northwestern Colorado for an apparently brief time span, as suggested by excavations at Dinosaur National Monument and elsewhere (Burgh and Scoggin 1948; Burgh 1950; Breternitz 1970; Gunnerson 1969; Marwitt 1970). Some workers

estimate Fremont abandonment of the area as early as A.D. 950 (Marwitt 1970:143); others place the final occupation at ca. A.D. 1150 to 1200 (Ambler 1966; Leach 1966; Breternitz 1970). The Fremont may have been replaced by Shoshonean groups. They may have adopted a hunting and gathering lifestyle, or they may have cohabited the area with the Shoshoneans (Berry n.d.).

The two Seep Ridge study tract sites with ceramics are large campsites located in hilly juniper-covered terrain. A previously recorded ceramic site in the study tract is situated nearby on Squaw Ridge. No indication of structures is present at any of these sites. Desert Side Notched points were the most frequently encountered point style found during the Seep Ridge survey, but this point is diagnostic of both Fremont and Numic occupation.

Ute/Shoshonean Occupation

Numic peoples apparently lived in the Uintah Basin from the thirteenth century to historic times. Although there is evidence to support a hiatus in occupation of the Basin in the eighteenth century (Steward 1974:53), projectile point typology suggests that the Numa lived in the area into the nineteenth century (Breternitz 1965; Holmer 1979). The previously-recorded possible Ute tipi ring (Chandler and Nickens 1979b), 42UN776, is the strongest evidence for late aboriginal occupation in the vicinity of the study tract. Ethnographic records place the Green River as the dividing line between "Eastern Utes" (Colorado horse-nomads) and "Western Utes" (Great Basin hunter-gatherers)(Stewart 1973). The Uintah-Ouray Indian Reservation was allotted to bands from both groups in the 1880s.

Regional History

Chandler and Nickens (1979b) have described Euro-American settlement of the Uintah Basin. Accounts of early expeditions through the region starting with the 1776 Dominguez-Escalante Expedition, are summarized in their work. These trips, many of which were U.S. Government-sponsored (e.g. the Fremont and Powell expeditions), supplied information about this isolated part of the country to settlers who arrived in the latter half of the nineteenth century. Prior to this time, Anglo interest in the Basin was limited to fur trading.

The history of the Seep Ridge project area is intimately related to gilsonite mining, the Uintah Railway, and the sheep industry. Sam Gilson was the first to exploit the hydrocarbon bearing his name by obtaining 7000 acres of gilsonite-bearing Ute lands in 1894 with congressional approval (Weber et al. 1977:275). The gilsonite boom commenced somewhat earlier than this date, however (Bender 1971:17). The asphalt-like solid occurs in deep veins oriented in a northwest-to-southeasterly direction in the Seep Ridge study tract and south of the White River. The company town of Bonanza originated as a mining camp for prospectors and workers who excavated deep trenches along the veins (Fig. 44) in order to mine the gilsonite. One of the largest veins is the Cowboy Vein, extending for miles southeast of Bonanza.

Figure 44. Miners excavated trenches to reach the gilsonite veins, which trend to the southeast north of the White River. Many trenches are hundreds of feet deep.

The Uintah Railway was built in the first years of this century to transport gilsonite from other large veins near Dragon, Utah, over Baxter Pass to the Rio Grande Railway head in Mack, Colorado. In 1905, a toll road was constructed by the Barber Asphalt Company to extend this transportation network to Uintah Basin settlements, to handle gilsonite transport from the Bonanza area, and to capitalize on the needs of the Basin's expanding livestock industry. One arm of the road proceeded from Dragon north to the Ignatio Stage Stop at the White River, on to Bonanza, then northwesterly to Alhandra, the Green River ferry stop. The road continued to Vernal.

Wool was a major source of freight revenue for the Railway (Bender 1971:58), but its inconsistent and seasonal traffic ranked it far below gilsonite. In order to handle the wool clip, the railway built large shearing pens four miles north of Bonanza. The pens approximately 8 miles west of Bonanza may be another link in this network, which transported nearly all Uintah County wool (Bender 1971:137). In 1912, the wool clip shipped from Watson totalled 1,036,323 lbs., filled 34 standard gauge cars and represented 170,000 fleeces, bringing about a dollar a fleece for the sheepman (Bender 1971:109). This information adds some sense of time and scale to the grazing impact on the area mentioned in Chapter 2.

Plans to extend the railway 19.4 miles from Watson to the gilsonite veins north of the White River were dropped when the gilsonite market fell. The 1920s saw an improvement in highways leading into the Uintah Basin and a concomitant loss by the railway (Bender 1971:165), which went out of business in 1935.

Operations of the Barber Asphalt Company moved to Bonanza in 1937. The American Gilsonite Company still supports the small settlement. Gilsonite, other energy-related industries, and sheep continue to bolster the local economy. Recent sites related to these industries were frequently observed by field crews.

Environmental Factors Contributing to Site Location

Chapter 5 presents a quantified means of predicting specific site locations based on discriminant functions. The three functions which most strongly account for prehistoric site locations are elaborated in this section. These three factors are presence of juniper, presence of sand dunes, and vantage. As would be expected, sites are densely clustered in areas that offer all three, notably Raven and Squaw Ridges. Other areas offer combinations of the three variables. Vantage is available in varying quality throughout the project area. As stressed in Chapter 5, a number of variables contribute to site location and although these three are major contributors, the influence of other locale-specific factors is strong in distinguishing site from nonsite locations.

The following tables summarize number of sites, site type, and cultural affiliation according to isolates of two of the variables defined above: juniper areas, dune areas with no juniper, and areas with neither juniper nor dunes.

Table 9. Site type and major environmental variables.

Environment	Total Sites	Site Type	
		campsite	limited activity
juniper	27 (79.4%)	14 (70%)	13 (92.9%)
dunes without juniper	4 (11.8%)	4 (20%)	0 (0%)
no dunes or juniper	3 (8.8%)	2 (10%)	1 (7.1%)
TOTAL	34	20	14

Table 10. Cultural affiliation and major environmental variables.

Environment	Cultural Affiliation				
	Unknown	Archaic	Archaic, Fremont or Shoshonean	Fremont	Fremont or Shoshonean
juniper	21 (84%)		1 (33.3%)	2 (100%)	3 (100%)
dunes without juniper	1 (4%)	1 (100%)	2 (66.6%)		
no dunes or juniper	3 (12%)				
TOTAL	25 (100%)	1 (100%)	3 (100%)	2 (100%)	3 (100%)

Juniper

Areas in the study tract which support juniper are the most easily defined. Juniper growth is limited to Raven and Squaw Ridges and their foothills in the northeast project area and to isolated stands north of the White River. Sites are not confined to juniper areas but are clustered within 1 kilometer of juniper. As Table 9 indicates, 79.4% of sites were found in juniper areas, which attests to the importance of this variable in site location. U.S.G.S. Quad maps were used to define areas of juniper growth. Field observations indicate that juniper has a slightly wider range than indicated on quads.

Sand Dunes

Dune locales are more difficult to define. Nonetheless, four broad areas where dunes are found can be described. As stated in Chapter 2, dunes seem to form where prevailing winds deposit source materials (sand). Locations thus depend both on wind direction and on availability of sand. The four areas where both criteria are present and where dunes therefore occur are: the lands north of Coyote Wash in the broad, sandy floodplains of large Coyote Wash tributaries; the lower portions of Coyote Basin, another broad, open area with numerous sandy tributary drainages; Raven Ridge, which offers a high exposed northeast face leeward of wind direction; and the east banks of Snake John Wash and its tributaries, a third large, sandy, relatively unentrenched drainage system. Small dunes are found on low northeast-trending ridge tops north of Coyote Wash.

Despite the definable presence of dunes in these areas, several problems with locating dunes must be delineated. First, as mentioned in Chapter 2, efforts to use infrared aerial photographs to map dunes were not successful, although Holmer (1979) was able to use the method for the Split Mountain Tract. "Remote sensing" of dunes would probably be fruitful with larger scale photographs of uniform quality. If soil and vegetation maps were available for the area they, too, would aid in mapping dunes. Secondly, thin layers of sand supporting a dune plant association can be identified virtually everywhere in the project area. Thirdly, definition of sand dune areas in this report is based on field observations of presence of dunes in sample units and on the above wind and sand source observations. The boundaries will undoubtedly need to be modified as more detailed environmental information becomes available. While 13 sites were located on dunes, only 4 were located on dunes without juniper. Definition of a "dune" zone isolates a variable that contributes to site location, but as the number of sites indicates, the zone includes a great many dunes with no cultural material. Once again, a multivariate approach is needed to account for site location.

Vantage

Although good vantage is obtainable throughout the project area, vantage quality varies. The best vantage is offered by the highest ridge system, Raven and Squaw Ridges, with elevations to slightly over 6000'. Good vantage is obtainable in and around Coyote Basin, a large bowl where low bluffs and ridges offer good views. This situation is repeated in the drainage basins of Coyote Wash tributaries to the west. Lesser vantage is offered by the ridges and bluffs of the remainder of the project area. Although bluffs are often high enough to provide a view, numerous other protuberances tend to block portions of the view spread. The deep canyons close to the White River have the poorest vantage. A feature that often occurs with good vantage is the presence of rock outcroppings, some with shelter potential.

Areas without juniper or dunes

The bluffs south of Coyote Wash and the low sage-covered ridges and benches in the southeast project area make up most of the remaining lands. An observation worth noting is that the three lush seeps found in sample units all occur here in association with sandstone outcroppings. Surprisingly, no cultural material was found near the seeps. The riparian environment on the verdant strip adjacent to the White River was also devoid of cultural material, a completely unexpected result since most of the 32 sites recorded by Berry and Berry (1976) were located along this strip.

Summary and Comparisons

Results of the Seep Ridge survey complement results of adjacent surveys. Holmer (1979), Chandler and Nickens (1979a, 1979b), Simms (1979), and Larralde and Nickens (1980) all found the highest site densities in juniper and sand dune areas. Hauck et al. (1979), Weber et al. (1977), and Berry and Berry (1976) found sites in association with rock outcroppings and drainages. Many Seep Ridge sites are located in or on rock outcroppings of the Raven and Squaw Ridge system. Four sites are associated with sandstone bluffs in the south half of the tract, closer to tracts studied by Hauck and Berry and Berry. As noted above, the major (unanticipated) difference in settlement patterns is the dearth of sites next to the river. One possible explanation may be the presence of low terraces on the streamsides surveyed in conjunction with the U-a and U-b oil shale leases as contrasted to the sheer-walled canyons that channel the river upstream and downstream.

Of the six historic sites found during the project, two are located in the juniper zone, two are located in the dune zone, and two are located on the remaining lands. Vantage appears to be the most important variable in location of the three sheepherder camps, all of which are on ridges or bluffs. The horse trap is very specifically located at the junction of two narrow barren clay canyons. The remaining two sites are enigmatic in both function and location, but the proximity of the "storage" cists to Bonanza suggests either a relationship to mining activities or some undefined purpose of gilsonite workers or their families. The incidence of four historic sites located on top of prehistoric sites suggests that some of the same attributes that attracted prehistoric peoples also drew recent peoples. Three of these attributes are undoubtedly vantage, wood, and shelter quality.

Site Density

A total of 40 sites was recorded in sample units during the survey, yielding a gross site density of 2.34 per square mile. Site density calculated for the 34 prehistoric sites only is 1.99 per square mile. This figure is only slightly higher than site densities of surrounding projects (Table 11). When all recorded sites in all surveyed areas within the project boundaries

Table 11. Comparative site density figures for the Uintah Basin.

	No. of Sites	Square Miles Surveyed	Sites/ Square Mile
U-a and U-b Oil Shale Leases (Berry and Berry 1976)	32	42.5	0.75
Oil Shale Lease Tract 7 (Weber et al. 1977)	5	3.25	1.54
Oil Shale Lease Tract 8 (Weber et al. 1977)	4	3.375	1.19
Natural Buttes Cultural Mitigation Study (Hauck et al. 1979)	9	5.875	1.5
Riverbend Gathering System (Simms 1979)	7	1.64	4.27
Red Wash Cultural Mitigation Study (Larralde and Nickens 1980)	26	20.0	1.30
Bonanza Power Plant Site (Chandler and Nickens 1979b)	37	5.75	6.43
Northern Water Corridor (Chandler and Nickens 1979b)	6	8.26	0.73
Southern Water Corridor (Chandler and Nickens 1979b)	4	4.2	0.95
Split Mountain Study Tract (Holmer 1979)	26	3.17	8.20
Coal Transport Corridors-Utah Portions (Chandler and Nickens 1979a)	7	2.71	2.58
Railroad and Water Transport Corridors (Reed 1980b)	3	.25	12.0
Transmission Line Corridors (Reed 1980c)	0	.31	.0
Seep Ridge Survey	40	17.1	2.34
Total Surveyed Area Within Seep Ridge Study Tract Boundaries*	74	29.34	2.52

*Includes Seep Ridge Sample; portions of Bonanza Power Plant Site; Coal, Water, Railroad and Transmission Line corridors surveyed within study tract boundaries; surveyed acreage of Oil Shale Lease Tract 7; and surveyed portions of the Riverbend Gathering System located within study tract boundaries.

are used in calculating site density the figure rises to 2.52 sites per square mile, still relatively low. However, these low site density figures distort the distribution patterns of sites in the study tract, as described above.

To get a more accurate view of site density, acreage was tallied for study tract lands according to presence of juniper, dunes, or neither. Since the sampling design provided by BLM was a random selection of sample units, field observations, topographic maps, and aerial photographs were used to aid in classifying acreage in units. Table 12 presents the results of this tally, which was also a means of constructing high, medium, and low sensitivity zones. Distribution of the zones has been discussed in the previous section. Some adjustments are necessary, however. One trend which becomes immediately obvious is the lack of differentiation between numbers of sites in the medium and low zones. We look to other projects for clarification: three previous surveys (Chandler and Nickens 1979a, 1979b; Larralde and Nickens 1980; and Simms 1979) have resulted in numerous dune sites recorded in and adjacent to the dune zone defined above. One of these surveys (Chandler and Nickens 1979b) suggests that site density is relatively high in this zone (Fig. 31). We believe that, although presence of dunes alone does not necessarily point to high site densities, a combination of other factors, for example, presence of large tributary drainages, desert pavement chert cobble fields, and the remaining contributing factors summarized in Chapter 5, leads to high site density "pockets" in areas where dunes are located.

The second adjustment is the addition of the White River riparian strip to the high sensitivity (juniper) zone, even though no sites were recorded there during the Seep Ridge Project. Berry and Berry's (1976) survey provides ample evidence that there is a high probability of site location along some portions of the White River terraces.

In summary, areas included in each zone are:

high - juniper areas as marked on U.S.G.S. topographic maps;
a 1 kilometer "buffer" area surrounding juniper areas;
a 1 kilometer strip along the White River.

medium - dune areas as defined by field observations, i.e. lands north of a 1 kilometer "buffer" area surrounding Coyote Wash; lower portions of Coyote Basin, as defined by the U.S.G.S. 5400' contour line; lands surrounding upper portions of Snake John Wash, as defined by the U.S.G.S. 5600-5900' contour lines.

low - remaining lands.

Adjusted acreage for the total tract and for areas surveyed is presented in Table 12, along with site densities for each zone. Zones are illustrated in Figures 45, 46, and 47.

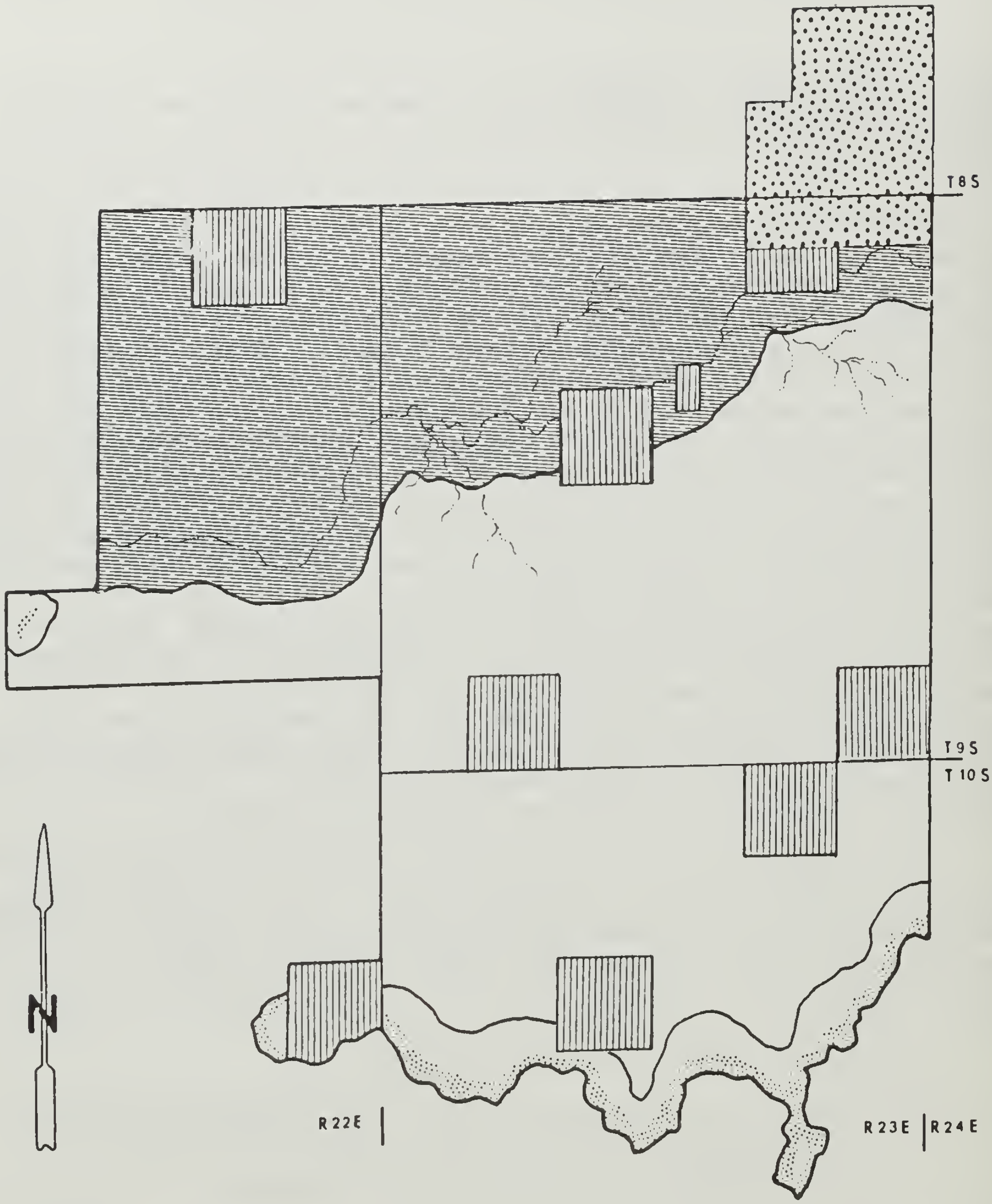
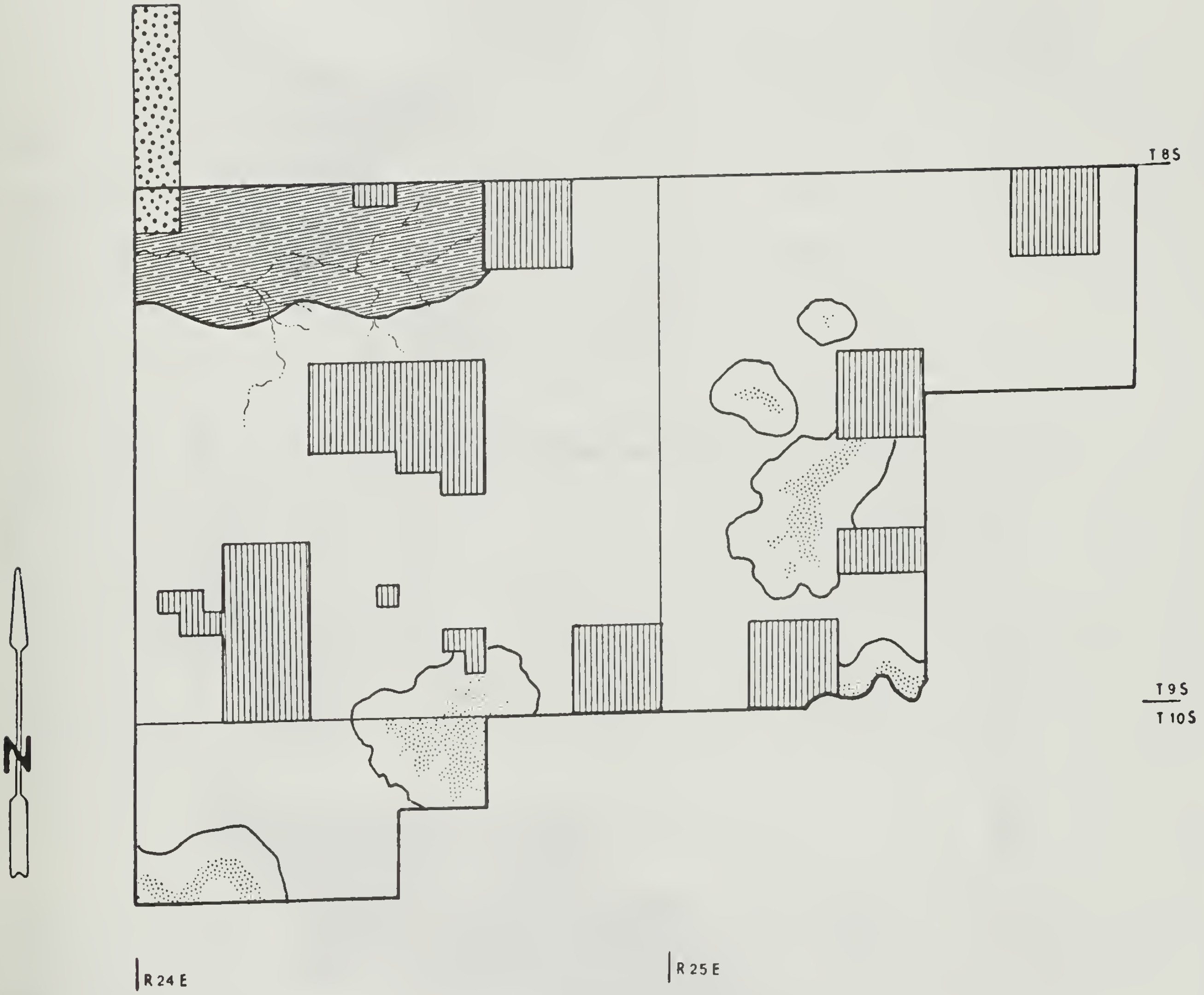


Figure 45. Sensitivity zones in the west third of the Seep Ridge study tract.



proposed Bonanza Power Plant site

state and private lands

high sensitivity zone

1 kilometer buffer area

medium sensitivity zone

low sensitivity zone

Figure 46. Sensitivity zones in the central third of the Seep Ridge study tract.

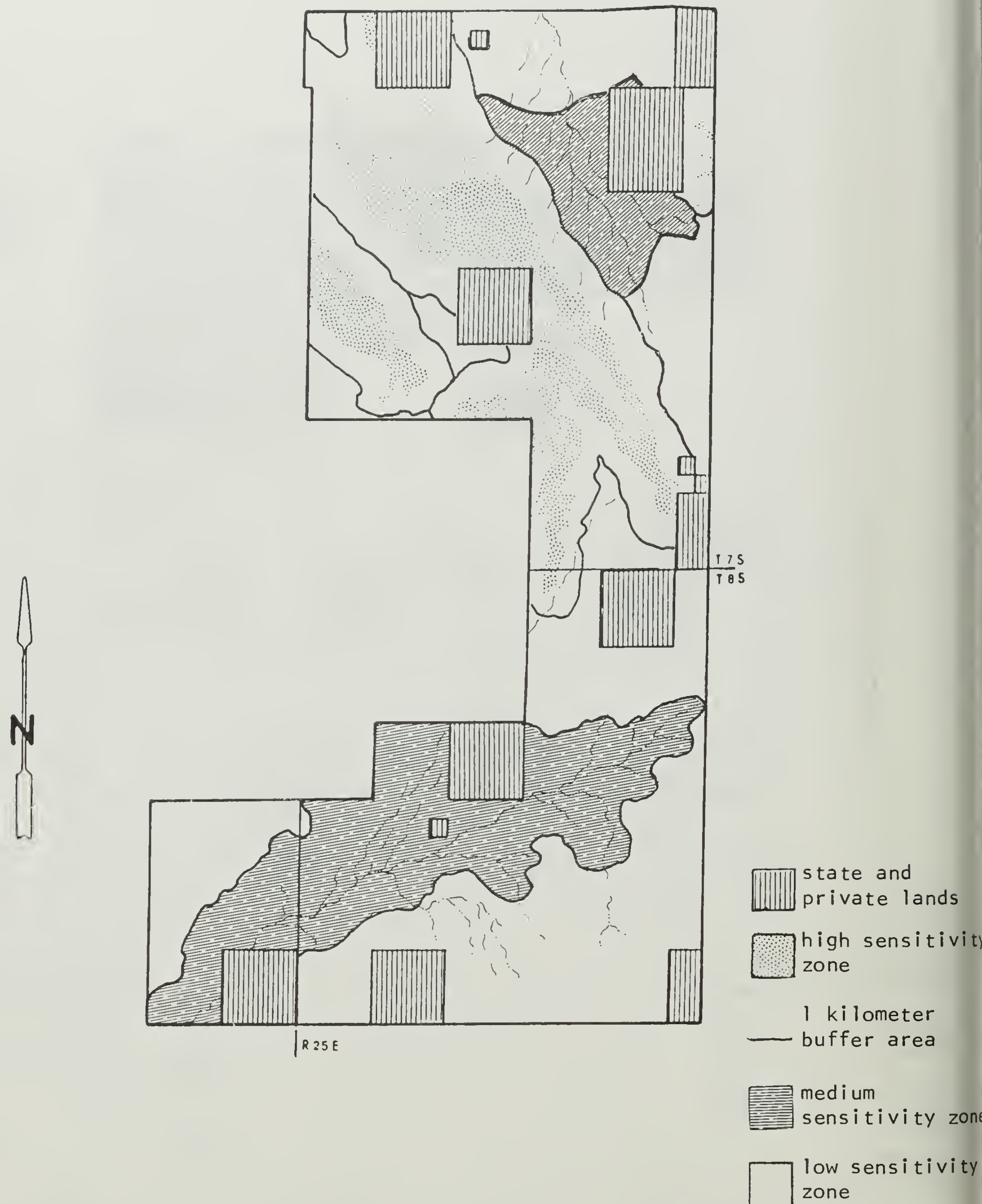


Figure 47. Sensitivity zones in the northeast third of the Seep Ridge study tract.

Table 12. Sensitivity zones and site density.

	Total acreage	Acres surveyed	# sites	Sites per square mile	Prehistoric sites per square mile
High	18147	2738.3	28	6.54	6.08
Medium	26987	2526.7	6	1.52	1.01
Low	64307	5678.9	6	.68	.45

Summary

Three sensitivity zones based on environmental variables have been constructed. Two important variables that form the basis for formulating the zones, presence of juniper and presence of sand dunes, account for 91.2% of site locations. "Buffer" areas have been added to both zones because of observed site locations or dunes in these areas. The White River floodplain was included in the high sensitivity zone because of high site densities reported in an adjacent survey along the river (Berry and Berry 1976). To jump ahead to the conclusions in Chapter 5, sensitivity zones based on one or two variables, important though they may be to site location, do not accurately account for specific site placement. A discriminant equation takes into consideration the gamut of decisions made by prehistoric populations about habitat qualities of specific loci.

Resources Available in the Project Area

In a general sense, three occupation "zones" have been defined for the project area. Chapter 5 presents functions which account for specific site locations within these general zones. We now need to assess resources in the study tract that may have made these zones attractive to prehistoric populations. Also needed is information as to when these resources are available, and in what quantity. We need to compare this information with data about resources used by Great Basin/Colorado Plateau ethnographic groups as well as with evidence from archaeological sites. Historic sources add to our knowledge of seasonality and quantities gathered, as well as food processing methods. An assessment of resources not available in the project area may shed some light on the study tract's overall low site density.

Unfortunately, a truly comprehensive summary of all this information is beyond the scope of this project. Archaeological information in the form of recovered and identified plant and animal resources from study tract sites is lacking. Eventual testing of sites will hopefully provide environmental data useful in reconstructing resource use patterns. We <u>can</u> look at availability of resources, as presented in the Moon Lake terrestrial ecology and vertebrate studies (Allan 1979, 1980; Smith 1980a, 1980b). Even this information is more limited than it seems, however.

Our perception of what constitutes food resources is more restricted than that of prehistoric populations. Data are also scant on which parts of plants were used; this limits conclusions we can draw about seasonal availability of plants. Our assessment of what constitutes "critical" resources is skewed not only by our lack of intimate knowledge of parts of this particular environment necessary for hunter-gatherer survival and by our food perceptions, but by the frequent use of ethnographic analogy in determining food resources and the incompleteness of those data.

Wheat (1967:8-16) provides an excellent description of the Paiute seasonal hunting and gathering cycle. This description, summarized below in Table 13, concentrates on the same patterns of wild resource utilization that Berry (1974) and Neilson (1978) have reconstructed of Fremont subsistence. Table 14 presents a list of plant foods found in the study tract and archaeologically at Fremont village sites (Madsen 1980), at Clyde's Cavern (Winter and Wylie 1974) and Sudden Shelter (Coulam and Barnett 1980) in the San Raphael Fremont area, and in accounts of Northern Ute (Smith 1974) and Paiute (Bye 1972; Wheat 1967) plant use.

Table 13. Patterns of Basin/Plateau wild resource use.

Season	Flora	Fauna
early spring	roots, marsh tubers	jackrabbits rodents leaving hibernation, e.g. ground squirrels
spring	greens, as available; wild onion; biscuitroot	fish migrating waterfowl and eggs
late spring/ early summer	early desert seeds: mustards mentzelia	rats, rodents, young jackrabbits
summer	rice grass, sego lily root, cattail pollen, chokecherries	ducklings, locusts, reptilia in addition to small mammals
late summer/ fall	berries (serviceberry, currant); sunflowers and other compositae; chenopodiaceae: atriplex, chenopod, greasewood	
fall	pine nuts	migrating waterfowl
late fall	late fall seeds	rabbit drives, communal antelope hunts
early winter	marsh plant seeds, late fall seeds	
winter	stored plant foods	dried meat, any fauna except carrion eaters

Using these data, we can conceive of bands camped close to marshes along the Green River for the winter, utilizing stored food, marsh resources, and fishing and hunting small game. As greens and roots become available in the lower elevations in the west project area in early and mid-spring and rodents and reptilia come out of hibernation,

Table 14. Seep Ridge Study Tract plants used by select prehistoric and ethnographic peoples in Utah.*

	Fremont/Sevier village sites (Madsen 1980)	Clyde's Cavern (Winter and Wylie 1974)	Sudden Shelter (Coulam and Barnett 1980)	Northern Ute (Smith 1974)	Paiute (Bye 1972, Wheat 1967)
Agropyron sp. (quickgrass)	X				
Allium sp. (wild onion)		X		X	X
Amelanchier spp. (serviceberry)	X		X	X	X
Artemisia sp. (sagebrush)		X	X	X	X
Asteraceae (aster)	X				
Astragalus sp. (locoweed, vetch, etc.)	X	X			
Atriplex spp. (saltbush)	X	X	X		X
Brassicaceae (mustard)	X				
Bromus spp. (bromegrass)	X				
Calochortus sp. (sego lily)				X	X
Chenopodium spp. (lambsquarter, goosefoot, etc.)	X	X	X		X
Cleome spp. (beeweed)	X				
Comandra sp. (bastard toadflax)	X				X
Cryptantha spp. (---)	X				X
Descurainia sp. (tansy mustard)					X
Ephedraecae (ephedra)					X
Eriogonum sp. (buckwheat, desert trumpet)		X	X		X
Helianthus sp. (sunflower)	X	X	X	X	X
Hilaria sp. (galleta grass)		X			
Juniperus sp. (juniper)	X	X	X	X	

Table 14, continued

	Fremont/Sevier village sites (Madsen 1980)	Clyde's Cavern (Winter and Wylie 1974)	Sudden Shelter (Coulam and Barnett 1980)	Northern Ute (Smith 1974)	Paiute (Bye 1972, Wheat 1967)
Lepidium sp. (peppergrass)		X	X		X
Muhlenbergia sp. (Muhly grass)					X
Mentzelia sp. (white stem blazing star)	X		X		X
Oenethera sp. (evening primrose)	X	X			
Opuntia spp. (prickly pear)	X	X	X		X
Oryzopsis hymenoides (Indian rice grass)	X	X	X		X
Phacelia sp. (---)	X		X		
Poaceae (bluegrass)	X				
Populus sp. (cottonwood)		X			
Prunus americanus (chokecherry)				X	
Psoralea sp. (scurf-pea)					X
Rhus trilobata (squawbush)				X	X
Rumex sp. (canaigre, wild rhubarb)		X			X
Salix spp. (willow)		X			
Sarcobatus sp. (greasewood)		X			X
Sisymbrium sp. (tansy mustard)					X
Sphaeralcea spp. (globemallow)	X				
Sporobolus spp. (sand dropseed)	X	X	X		X
Stipa comata (needle and thread grass)			X		
Tetradymia sp. (horsebrush)		X			
Yucca sp. (---)	X	X		X	X

*Fremont/Sevier village sites: high pollen counts or plant macrofossil or coprolite evidence
Clyde's Cavern: coprolite evidence
Sudden Shelter: plant macrofossil evidence
Northern Ute and Paiute: ethnographic evidence

these lands expand the foraging base. Antelope, whose spring diet consists of grasses and forbs (Severson 1966; Hoover 1966), might also be particularly abundant at this time in open, low elevation areas. Cycles of maturation of various seeds start with mustards in early summer. Gatherers could follow maturing seed crops from lower to higher elevations, from west to east. The rice grass harvest occurs in late June. Other root, leaf, seed, and berry crops become increasingly available, culminating in a late summer peak harvest period. Utes refer to August as "everything ripe now" (Smith 1974:279). With fall comes a second season for migrating waterfowl, and forays to higher elevations on Blue and Split Mountains and on the Tavaputs Plateau for pinyon nut gathering. Rabbit drives and communal antelope hunts are late fall activities, when bands are returning to river marshes to make winter camp. Antelope form herds in the late fall, preferring to winter in open areas such as the east and southeast study tract with good vantage and plentiful shrubs like sagebrush, which constitute most of their winter diet (Severson 1966; Hoover 1966). Since resources are unevenly available over a broad area, strategic plans for harvest must have been necessary (Binford 1980). Any human group living in the Uintah Basin and depending on wild foods would have had to deal with similar restrictions, including the Fremont.

It appears that the two resources that consistently appear in accounts of Basin/Plateau hunter-gatherer subsistence are absent in the project area: marsh plants (cattails, tule) and pinyon nuts. Marsh plants are available year round, while pine nuts are gathered in fall but crops vary a great deal from year to year as to productivity. We can suggest that groups wintered below the project area, using the Seep Ridge tract's dune fields, juniper stands, and sage basins as an early spring and summer gathering base. Fauna could have been exploited from the ridges in late fall on the return from pinyon nut gathering or at other times during the year. Grady (1980) does not see seasonal hunting patterns among ethnographic groups for large game animals and believes they were taken whenever possible. In any case, plant resources and small game were probably staple resources, according to ethnographic and archaeological evidence (Madsen 1980; Winter and Wylie 1974; Smith 1974; Wheat 1967).

We have little information about how wide a range was travelled by hunter-gatherers in this area and what quantities of resources were available. We know that pinyon pine is not available in the area comprised by the Seep Ridge and Red Wash Study Tracts, which cover at least 400 square miles between the White and Green Rivers. We also know that marshes are present in some areas along the bank of the Green River here. Resources may not have been consistently available in quantities that would have made an annual gathering round through the study tract worthwhile. Or an overall low human population density may be responsible for the sparse site distribution.

Raven and Squaw Ridges deserve special comment: these ridges appear to be havens of resource availability. Aside from the shelter of the ridges themselves, dunes along the northeast face and in nearby

Snake John Wash support a plant association that features Oryzopsis. Juniper is obtainable for fuel, shelter, and food. The bordering sage community supports a high diversity of fauna (Table 4). Oolitic chert is available for tool manufacture. An excellent vantage for observing game movement or human movement can be had both to the northeast towards Snake John Reef and to the southwest overlooking Coyote Basin. The location of clusters of sites near gaps in the ridge is probably related to migration patterns of game or people.

The next section discusses available quantities and gathering methods of rice grass, an important plant resource.

Oryzopsis gathering methods, processing, and yield

As suggested in Chapter 2, the original range condition of the study tract may have differed from its present condition. We are not able to assess past quantities of available resources, but we can measure present quantities. Indian rice grass, Oryzopsis hymenoides (Fig. 48), has been singled out as a resource of importance to prehistoric populations because of its relative abundance in some areas where prehistoric sites are located, notably sand dunes (Singer 1979). These sites often have large quantities of ground stone, suggesting that prehistoric bands camped on or near the dunes to harvest grasses. As Singer (1979) describes, Indian rice grass has evolved so that it grows well under dunic conditions; it comprises 35% of living cover on dunes in the proposed Bonanza Power Plant site, and has a relative abundance index of 976.1, approximately four times that of the next most abundant plant in the dune association (Allan 1979:23). As Allan (1979) mentions, the first visual impression of the dune plant association is that shrubs dominate, but rice grass, in fact, represents the dominant growth and other grasses are also more abundant than shrubs.

Fieldwork for the Seep Ridge project encompassed the rice grass ripening cycle, a good opportunity to observe the grass during different growth stages as well as to look at other spring and early summer floral resources. Our objectives were to take advantage of this situation by: 1) making observations on the ripening cycle in different locales; 2) taking notes on the plants comprising the dune association; and 3) gathering data on frequency of rice grass growing on and off dunes and on gathering methods, time expenditure, processing, and yield. Two dunes were selected for observation. One was located approximately two miles west of Bonanza near the Bonanza-Ouray road. The second was located immediately north of project boundaries in a free dune field and is the locus of two prehistoric campsites recorded during the Red Wash Project (Larralde and Nickens 1980).

We mapped both dunes and inventoried plants growing on the dunes (Fig. 49) using a radial transect method similar to the one Allan (1979) describes (Appendix 6). Because Allan's inventories of dune association plants agree with ours and are more exact and more complete, they are included in this report (Appendix 6).

Figure 48. Oryzopsis hymenoides, Indian rice grass, and Helianthus sp., sunflower, two economic plants plentiful on dunes in the study tract.

Figure 49. A two-person crew inventories plants growing on the dune chosen for Oryzopsis observation.

Singer (1979) reports that rice grass ripening cycles depend on rainfall and elevation and records recent harvest periods as follows:

1978	mid-July
1979	mid-June

For the Seep Ridge tract, we can add:

1980	late June (elevation - ca. 5000')

However, seed casings were first observed opening at lower elevations (4800') in mid-June and were observed in varying stages of seeding at higher elevations through mid-July. Late June was the optimal harvesting time. Although O'Connell (1975:18) reports that Oryzopsis seeds "can ordinarily be collected only during the short period between the time they ripen and fall to the ground...a two or three week period in late June or early July," the gathering period might be prolonged by harvesting immature seeds. Since the seed cycle is short and the resource in this area is most abundant on free dune fields in the central project area, the seasonal rounds of hunter-gatherers were probably adjusted to take advantage of the peak harvest.

The dune north of the study tract was chosen for rice grass gathering because of its large size. Six 20-meter square study plots oriented north-south/east-west were placed on and off the dune. Plots were spaced so as to include, variously, the dune crest, dune slope, a blowout near one prehistoric site, and off-dune vegetation.

The grass gathering study consisted of a team of two workers, one gathering and the other timing and tallying the number of plants gathered. Seeds from all plants in a plot were gathered. Some difficulty was encountered in defining what constituted a plant, since rice grass grows in bunches, some of which are quite extensive. This was a subjective decision based on surface spatial continuity or discontinuity. Three gathering methods were tried. One consisted of cutting and gathering stems and grass with a metal knife; the second consisted of breaking off and gathering stems and seeds by hand (Fig. 50); the third consisted of pulling seeds off the stems with a closed hand. Methods not tried were those dependent on beating seeds from stems into containers. Seeds are tenaciously attached to the seed casings until ready to fall, and even seeds from the same plant are not ready to fall at the same time. It seems doubtful that this method, which depends to such a great extent on exact timing, was ever used by gatherers of rice grass, although it is documented for other seed crops like mustards (Wheat 1967). Various picking methods can be used at any time after seeds have developed and before they fall, which is a span of three weeks to a month.

The most successful method we used follows Wheat's (1967:11) account of Paiute rice grass gathering.

Figure 50. A gatherer harvests rice grass by the fast method of breaking off stems by hand.

> In July, the Indian rice grass . . . was ready to harvest. Before the nutritious seeds fell to the ground, the women cut great armloads of the grass to be carried to threshing pads of sun-baked earth. Here, in the cool of the day, old women singed off the little black seeds which clung so stubbornly to the stems. Moistening the sheaves to retard flash burning, they placed handfuls on a small fire. As the grass was consumed, the hard-shelled seeds dropped, roasted, into the ash. Later they were cleaned and husked on a flat stone to make meal for gruel.

Wheat mentions above that women cut the grass. We found that breaking the grass was faster and easier, but sore hands may be a result of prolonged gathering and a cutting tool would perhaps be more efficient with practice. Pulling seeds off stems was a slow and tedious process. It solves the problem of how to remove the larger stems, but leaves the husks and the tiny stems still on the seeds. Table 15 summarizes locations, gathering time, number of plants and gathered weight of seeds from each plot.

The stem-removing method described by Wheat (quoted above) was also used with success. Seeds are attached by tiny thin stems to the larger stalk of grass. These little stems burn off very quickly, causing a shower of seeds to fall from the burning grass. Further processing includes winnowing away the ash and husking and grinding the roasted seeds. Timing and practice again determine the success of this method. Too hot and fast a fire burns the seeds; too slow a fire on wet grass puts the fire out and the stems remain. After burning, it would take a skilled winnower to use correct motions and proper winnowing trays to remove the ash and remaining stems, retaining only the seeds. Use of the modern convenience of a 1/16th-inch screen left us with a mixture of ash, tiny seeds, and burned stems. The association of Indian rice grass seeds with charcoal in coprolites from Clyde's Cavern (Winter and Wylie 1974:309) comes as no surprise.

The abundance of rice grass and the ease in gathering large armloads of grasses compensate for the seemingly low yield. Caloric value of rice grass seeds is 3.9 per gram (Carpenter and Steggerda 1939; Steggerda and Eckart 1941). The work of gathering the grass, when done as we believe it was, involved little movement and the major drawback to our gatherers was back strain or leg strain from bending or squatting.

The average unhusked rice grass yield from the four study plots harvested on the dune was .6 gram per square meter. At that level of productivity, one square kilometer of productive dunes would yield an approximate 600 kilograms of unhusked rice grass seed. The facts that not all dunes may be as productive, that dunes are separated by barren areas, and that prehistoric gatherers might not be as systematic in picking all grass in a defined area are balanced by the probable higher yield of dunes not subjected to overgrazing and by the greater processing skills of prehistoric gatherers. Gathering time and caloric outlay in gathering and processing must also be compared with yield. It took one

Table 15. *Oryzopsis* gathering: summary of data.

Study plot	Location	Plant Frequency	Gathering Method	Total Gathering Time (person-minutes)	Unhusked Yield in Grams	Total Calories
1	blowout area near prehistoric campsite	158/400 m^2	cutting stalks with metal knife	1 hr. 30 min. (90 min.)	177.5	692
2	off dune west of preshistoric campsite	14/400 m^2	breaking off stalks by hand	13 min.	7.1	28
3	dune blowout	301/400 m^2	pulling seeds off stalks with closed hand	2 hrs. 55 min. (175 min.)	191.7	748
4	north slope of dune, below crest	209/400 m^2	breaking off stalks by hand, then pulling seeds off with closed hand	4 hrs. 30 min. (275 min.)	411.8	1606
5	crest and northeast slope of dune	289/400 m^2	breaking off stalks by hand	1 hr. 5 min. (65 min.)	142.0	554
6	off dune north of prehistoric campsite	20/400 m^2	breaking off stalks by hand	15 min.	7.1	28
average:	on dune:	239/400 m^2 (.6/m^2)		151 min. (2 hrs. 31 min.)	230.8 (.6/m^2)	900
	off dune:	17/400 m^2 (.04/m^2)		14 min.	7.1 (.02/m^2)	28

Note: Yield for plots 1 and 5 was processed by burning off stems. Weight represents a slightly lower proportion of husks and stems to seeds for these plots.

unskilled gatherer 23 seconds to gather a square meter of grass on the dune. At this rate, gathering one square kilometer of grass would take approximately 64 hours. Processing would add many more hours.

In any case, rice grass does emerge as a potentially plentiful resource. Rehr and Witter (1977:114) review foraging ranges for hunter-gatherers. They cite the usual gathering range for women restricted by infants and young children as three to four miles per day. Although the above estimates of rice grass yield omit many important variables in harvesting (size of group, for example), it appears that a small group of people could successfully harvest large amounts of grass over an area of several square kilometers from one campsite. The free dunes that form in fields would offer the advantage of a continuous source of grass with no intervening topographic hindrances like ridges.

King and Casebier's (1976:11) account of Paiute rice-grass gatherers in the eastern Mohave "camping in the open" is apt, since little or no shelter aside from that offered by dune depressions is available on the dunes where Oryzopsis is most abundant. Absence of shade and high surface temperature of sand can make rice grass gathering in the heat of the day unpleasant in late June. Water is necessary for the stem-removing method Wheat describes, but sand or some other fire retardant could probably be used instead.

Singer summarizes ethnographic and archaeological records of Oryzopsis use. Interestingly, burned deer bones (Odocoileus hemionus) were the most numerous items associated with hearths at Bulldozer Dune (Madsen 1976). No burned bone of any kind is apparent from surface evidence at the dune sites recorded in the central project area, Red Wash, or the Bonanza Power Plant site (Larralde and Nickens 1980; Chandler and Nickens 1979b), and the mule deer range is several kilometers from these dunes. We would expect faunal remains, if any were recovered, to be limited to small game and an occasional antelope at these sites. Dune sites near Raven Ridge are situated in a different econiche where mule deer may be available, however.

CHAPTER 5

A REGIONAL PREDICTIVE MODEL FOR SITE LOCATIONS

Introduction

As outlined in the Seep Ridge proposal, one of the primary goals of the Seep Ridge project is the development of a regional predictive model which would "take into account the results of the Class II inventories and other work in the general area." Development of this model is a step towards comprehensive planning to provide direction for future research and management of the cultural resources of the region. For the purposes of this study, the region has been defined as the Bonanza Planning Unit of the Bureau of Land Management's Vernal District in northeastern Utah. The region is bounded on the north by U.S. Highway 40, on the east by the Utah-Colorado state line, and on the south and west by the White and Green Rivers, respectively. Although neither the highway nor the state line would have had any bearing upon prehistoric settlement of the area, the two major rivers are geographical boundaries which would have been meaningful to the prehistoric inhabitants.

The specific goal of the regional analysis presented below is the development of a predictive model of site location based on environmental variables. The study relies on multivariate statistical analysis to examine the complex interrelationships among environmental attributes of sites as compared to those of a set of points where sites are known to be absent ("nonsites"). The ultimate goal is the derivation of a formula through which the probability of site occurrence at any given geographic point can be calculated, thus abolishing the reliance of cultural resource managers upon imprecise sensitivity zone maps for determination of cultural resource potential.

It should be kept in mind that the ensuing analysis is only the first step toward this goal. Although considered to be relatively successful, refinement of the predictive model developed herein was precluded by time and budgetary limitations.

Site Locational Analysis

Archaeologists have approached the problem of site locational analysis from several perspectives, with the underlying similarity being a focus upon the relationship between prehistoric sites and their physical environment. The efforts of the Southwestern Anthropological Research Group (SARG; Gumerman 1971; Euler and Gumerman 1978) gave impetus to numerous attempts at identifying key environmental variables influencing site location. One of the criticisms of the SARG approach toward answering the question "Why are population aggregates located where they are?" (Gumerman 1971:3-4) is that it has not taken into account comparative negative data regarding the environmental attributes of loci where sites are _not_ located (Chandler and Euler 1978:83).

Recently, however, archaeologists have begun to address this problem. For example, Holmer (1979) compared a group of sample units containing sites with a group of surveyed sample units in which no sites were present. Through the multivariate statistical technique of discriminant analysis he was able to identify the environmental attributes which differentiated one group from the other. This information was used to assign high, medium, and low probabilities of site occurrence to unsurveyed sample units in the Split Mountain project area of northeastern Utah. Kvamme (1980) analyzed the environmental attributes of 58 sites and 116 nonsite loci in the Glenwood Springs Resource Area of western Colorado. Once again, discriminant function analysis was used to identify the environmental attributes which, in conjunction with one another, differentiate locales containing sites from those which do not. Equations were developed so that the probability of site occurrence at a given geographical point could be assessed. The Seep Ridge regional analysis is patterned after Kvamme's work.

Data Base

The data base for the regional analysis of site location is comprised of all the prehistoric sites in the Bonanza Planning Unit for which complete data were available (a total of 132) and a random sample of 68 points at which sites are known to be absent. Since the analysis is based on a model of hunter-gatherer settlement, historic Euro-American sites were deleted from the sample. Due to small sample sizes, all prehistoric sites were considered as a whole, regardless of site type or cultural affiliation. Although not ideal, this lumping is thought to be valid on the grounds that each of the sites is a product of hunter-gatherer occupation.

The primary source of data is the Seep Ridge Class II inventory which recorded 34 prehistoric sites, and inventoried 216 sample units (out of a total of 274) which contained neither sites nor isolated prehistoric artifacts. A random sample of 68 (twice the number of sites) of the sample units devoid of cultural materials was selected using a random numbers table (Hoel 1971), and a "nonsite" point was plotted at the exact center of each of the 68 selected units.

The body of "other site" data is derived from several major archaeological projects and miscellaneous surveys conducted in the region in recent years. Data on a total of 98 prehistoric sites were obtained from site forms and map locations. Although Bureau of Land Management maps show several other sites within the Bonanza Planning Unit, insufficient data were available to allow for thorough analysis and the sites were consequently omitted from the analysis. Optimally, all prehistoric sites in the region, as well as hundreds of nonsites plotted in areas which have been surveyed and found to lack sites would be incorporated into the data base in order to allow for a truly definitive analysis and the development of a strong predictive model.

Summary of site data

As a first step in compiling a regional "data bank" of site characteristics, the following cultural variables were recorded in addition to the environmental attributes measured for each site:

1) source of site data (project name)

2) 42UN site number

3) UTM grid location

4) site type

5) artifact assemblage present at site

6) cultural features present at site

7) site size

8) cultural affiliation

For the most part, these variables were not needed for the present study but are available in punched card form for future research. A brief summary of the sites recorded on projects other than Seep Ridge (hereafter referred to as the "other sites") is presented below.

<u>Moon Lake Project</u> (Chandler and Nickens 1979a, 1979b)

Several of the 53 prehistoric sites recorded on the Moon Lake Project lie within the Seep Ridge project area. The majority of sites are clustered near Kennedy Wash, within the boundaries of a proposed power plant site. Others are located along rights-of-way from the power plant site north to the Green River, south to the White River, and east to the Colorado state line. Thirty of the sites are open lithic scatters, twenty are open campsites, two are quarries, and one is a Ute tipi ring. Three of the sites are considered to be Archaic, one is a Fremont site, two are Shoshonean, and the remaining 47 are of undetermined age or cultural affiliation.

<u>Red Wash Class II Inventory</u> (Larralde and Nickens 1980)

A total of 25 prehistoric sites was recorded in a stratified random sample of 40-acre sample units in a project area adjacent to the Seep Ridge project area. Nine are open lithic scatters, fifteen are open campsites, and one is a quarry. Two sites have diagnostic Archaic artifacts, three are attributable to the Fremont culture, and 18 are of indeterminate origin.

White River Survey (Berry and Berry 1976)

Eleven prehistoric sites, including a previously-recorded rockshelter, located along the north bank of the White River were recorded by the Antiquities Section in conjunction with their cultural resource inventory of oil shale lands. Seven of the sites are described as open campsites and four are rockshelters. The cultural affiliation of the sites is as follows: one Archaic, one Fremont, one Fremont or Shoshonean, and six indeterminate.

Oil Shale Tract Seven (Weber et al. 1977)

Four prehistoric sites were recorded in sample units within oil shale tract 7 by the Laboratory of Public Archaeology at Colorado State University. These sites lie within the Seep Ridge project area. Two sites are rockshelters, one is an open campsite, and one is a structure of presumable aboriginal origin. All four are of undetermined cultural affiliation.

Riverbend Gathering System (Simms 1979)

Three open prehistoric sites--two campsites and one lithic scatter--were recorded along a pipeline right-of-way. The cultural affiliation of these sites is not known.

Miscellaneous surveys

One rockshelter (42UN382) and an open campsite (42UN554) were recorded by the BLM and the Antiquities Section, respectively. Neither site possessed diagnostic artifacts.

Selection and Measurement of Environmental Variables

Variables measuring a number of environmental attributes between which sites were expected to differ from nonsites were selected for analysis on the basis of a model of hunter-gatherer subsistence and settlement (Jochim 1976; cf. Kvamme 1980). Criteria influencing hunter-gatherer site location decisions include the following: proximity to water, food, and fuel resources; a view of the surrounding terrain; protection from the elements; and level ground on which to camp. Sites are expected to be in environmental situations which maximize ease of access to these several necessities, whereas a random distribution of nonsites is expected.

Although measurements of a few environmental attributes were the result of field observations, most measurements were taken from U.S.G.S. 7.5' topographic quadrangles. In some instances, field-gathered data could be cross-checked with map data.

The specific variables selected and the methods used for their measurement are described below and in Appendix 8.

Water Resources

Since water is a fundamental human need, it is to be expected that sites will be located in proximity to water sources. A number of water-related variables were measured in order to explore the relationship between site location and water resources in the project area.

Few sources of permanent water exist in northeastern Utah, with the prominent sources being the two major rivers--the White and the Green--which bound the project area on the west and south. The distance from each site or nonsite locus to the nearest river was measured to the nearest 100 meters, using U.S.G.S. topographic maps and the Bonanza Planning Unit map. With the exception of a few campsites located along the banks of the White and Green Rivers, the distances were generally of sufficient magnitude to preclude the utilization of the rivers as primary water sources. A primary water source, proximal to the site locus, was consequently defined. Three types of primary water sources occur in the project area: the permanent rivers noted above; permanent seeps or springs; and intermittent streams. The latter are indicated on U.S.G.S. topographic maps as blue-line drainages. The horizontal distance and vertical distance from each site and nonsite locus to the nearest primary water source was measured on U.S.G.S. maps.

Floral Resources

Local vegetation is an important factor to hunter-gatherer site location due to the exploitation of floral resources for food, fuel, and shelter. Vegetation zones are also correlated with game animal habitats.

Dominant on-site vegetation and dominant vegetation of the area surrounding the site was noted on site forms and Seep Ridge project sample unit records. Five categories of dominant vegetation were observed: juniper, sagebrush, saltdesert shrubs, grasses, and riparian species. Several loci were located in areas barren of vegetation. For purposes of the multivariate analysis, a dichotomous variable was created which reflected whether the on-site vegetation was the same as ("ECOTONE" = 0), or different from ("ECOTONE" = 1), the vegetation of the immediate vicinity.

Previous work in the region has demonstrated a high correlation between the presence of juniper and the presence of prehistoric sites (Larralde and Nickens 1980). The distance was measured from each site or nonsite to the nearest juniper area as indicated by green shading away from the rivers on U.S.G.S. topographic maps. In instances where juniper was recorded as the dominant on-site vegetation but was not shown on the U.S.G.S. maps, its presence was accepted for that specific site only.

An association between prehistoric site location and stabilized sand dunes has also been observed in northeastern Utah, and is thought to be due in part to exploitation of the relatively abundant floral resources of dunes (Singer 1979; Simms 1979; Larralde and Nickens 1980; Chandler and Nickens 1979a, 1979b). Site association with dunes was originally recorded in the field as a nominal variable expressing the location of the site with respect to the structure of the dune. For purposes of the analysis, the variable was rescaled to a dichotomous variable recording dune presence or absence at each site or nonsite. Data for nonsites were obtained from sketches made by survey crews of dune location within the surveyed sample units.

Topographic Situation

As has become standard archaeological practice in site recording, observations were made in the field regarding the landform on which sites were located. A determination of landform for nonsites was made from U.S.G.S. topographic maps. Nine classes of landform were recorded:

1) flats (plain)
2) mesa
3) ridge top
4) saddle
5) bench or terrace
6) slope (hillside or talus)
7) canyon rim
8) valley floor or floodplain
9) knoll or hilltop

As will be seen below, this variable did not prove to be useful in the development of a predictive model of site location, largely due to the fact that the important characteristics of these landform categories were better and more objectively quantified by other topographic variables.

Site and nonsite elevations were taken off of U.S.G.S. topographic maps.

The steepness of the terrain surrounding each site or nonsite was measured by two variables: slope and local relief. On-site slope (percent grade) was recorded as a field observation for most sites. For the remaining sites and the nonsites, slope was measured on U.S.G.S. maps, using a slope indicator template. The maximum vertical distance within ½ kilometer radius of sites and nonsites was calculated from U.S.G.S. topographic maps, using a mylar template on which a circle with a ½ kilometer radius had been drawn.

The shelter quality of a specific locale, or the degree to which that locale is protected from the elements, is regarded as being a critical factor in hunter-gatherer site locational strategy (Jochim 1976:51). A first attempt at quantifying this variable has been made by Kvamme (1980:98-99), and his ordinal scale of twelve ranked categories describing potential sheltering situations was applied to this analysis.

The highest possible shelter quality rank was assigned through judgments made on the basis of data contained on site forms and from U.S.G.S. topographic maps, on which green shaded areas were considered to be forested. As can be seen from the following scale, an increase in the rank of shelter quality reflects increased protection from wind, weather, and sunlight. Shelter from flash floods is not considered by this particular variable, but is instead considered in the "distance to primary water" variable.

0 - nonforested hilltop, ridge crest or high point

1 - flat (horizontal or sloping) non-forested area

2 - river valley floor (valleys are greater than 150 meters wide)

3 - immediately below crest of ridge or hilltop (within 50 meters) in non-forested area

4 - near forest edge (within 50 meters) but outside of forest

5 - in topographic depression such as a ravine or drainage in non-forested area

6 - clearing within forest (clearings have diameters greater than 50 meters)

7 - in forest on hilltops, flat, or sloping areas

8 - in forest, in a ravine or drainage depression

9 - in forest, immediately below (within 50 meters) crest of ridge or hilltop

10 - base of a vertical rockface scarp such as a canyon wall

11 - rockshelter or cave

Site exposure was measured on a scale of 0 to 180 degrees in order to indicate northerly or southerly slope of site terrain. It was expected that locales with southern exposures would be preferred site loci due to increased warmth from sunlight. Exposure was measured on U.S.G.S. topographic maps, using a protractor to measure the angle of a line drawn perpendicular to the elevational contours. Eastern exposure is not distinguished from western exposure by this method of measurement; that is, a reading of 90° could be either east <u>or</u> west, with the importance being that the bearing is halfway between north and south. The merits of this method of measuring exposure have been convincingly demonstrated by Kvamme's work (198:114-117).

A view of the surrounding terrain has been considered to be an important criterion for hunter-gatherer site location in order that the movement of game animals--and perhaps neighboring peoples--might be observed (Jochim 1976:49, 51, 55). Measurements of prehistoric site location with respect to overviews have proven useful in previous settlement studies (Judge 1973, Brown 1979, Kvamme 1980). Following Kvamme's example, the distance to the nearest vantage point and the degrees of viewspread were measured for each site and nonsite locus.

Points of vantage were identified on U.S.G.S. topographic maps as hilltops, canyon rims, or ridge crests which possessed slopes steeper than 30% and which were at least 40 feet higher than the surrounding terrain. Vantage points, as a general rule, stand out in sharp contrast to the low relief which characterizes much of the project area. The concept of viewspread has been defined by Brown (1979:197) as the "number of degrees of surrounding terrain visible from a site." Viewspread was determined from U.S.G.S. topographic maps by measuring the angle of lines drawn from the site or nonsite point along the same elevational contour, and encompassing elevations lower than the point of interest (Fig. 51). For example, a site located in a drainage might have a viewspread of only a few degrees, whereas a site at the base of a cliff might have an 180° view, and one atop a hill or in a broad, flat basin would have an unobstructed view in all directions (i.e., 360°).

Individual Factors Influencing Site Location

Prior to the selection of environmental variables to be used in the multivariate statistical analysis of site location, the distributions of nonsites, Seep Ridge sites, and other sites in the region were compared on a univariate basis. In this manner, the influence of single environmental factors upon site location were assessed.

For variables measured on an interval scale, value ranges and measures of central tendency (i.e., means and standard deviations) are presented in Table 16. Figures 52 to 56 illustrate the frequency distributions of each variable for Seep Ridge sites, other sites, and nonsites. The Komologorov-Smirnov two-sample test was performed on each pair of groups for all variables which were measured on an ordinal or interval level scale. This nonparametric test is more suited to the data than the parametric *t* test for assessing whether the distributions could belong to the same population, as it makes no assumptions of normally-distributed data. Furthermore, the K-S two-tailed test is sensitive to any kind of difference in the distributions from which the two samples were drawn, including differences in location (central tendency), dispersion, and skewness (Siegel 1956:127). Chi-square tests were performed on variables measured on a nominal scale. The results of these tests are presented in Table 17 and Figures 57 to 59.

As will become evident below, the Seep Ridge sites, for the most part, exhibit the least amount of variability with respect to site location and the nonsites exhibit the greatest amount of variability. The larger group of sites occupies a median position on the spectrum of environmental variability.

Water Resources

Contrary to the expected pattern of site location, sites are located at significantly greater distances from the major rivers than the nonsites, with Seep Ridge sites being even farther from the rivers

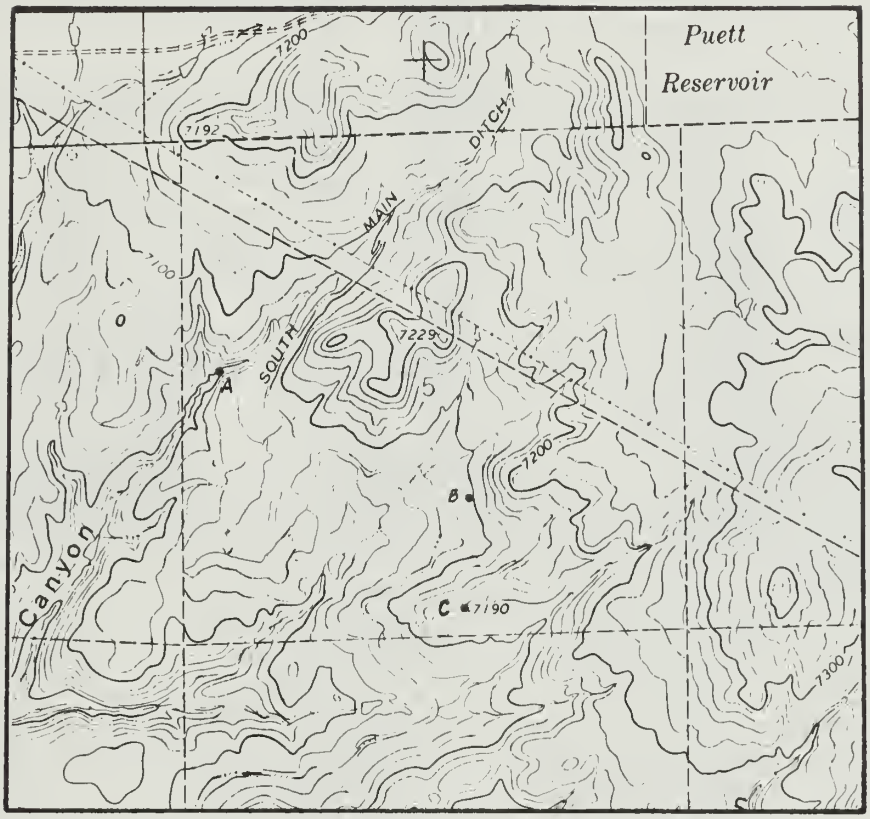


Figure 51. Example of viewspread measurement. Point A has a viewspread of 12°; Point B has a viewspread of 180°; and Point C has a 360° viewspread.

Table 16. Site and nonsite ranges, sample means ($\bar{x}$) and standard deviations (s) for environmental variables measured on an interval scale.

Variable	Seep Ridge (n = 34)	other sites (n = 98)	nonsites (n = 68)
Distance to nearest river (km)	range: 1.4 to 23.8 $\bar{x}$ = 15.253 s = 5.6	range: 0 to 20.5 $\bar{x}$ = 11.079 s = 5.621	range: 0.1 to 22.9 $\bar{x}$ = 6.99 s = 5.263
Distance to primary water (meters)	range: 0 to 600 $\bar{x}$ = 223 s = 183	range: 0 to 600 $\bar{x}$ = 146 ---	range: 0 to 500 $\bar{x}$ = 178 s = 142
Height above primary water (feet)	range: 0 to 612 $\bar{x}$ = 64.765 s = 105.534	range: 0 to 200 $\bar{x}$ = 27.918 s = 33.423	range: 0 to 130 $\bar{x}$ = 31.103 s = 29.025
Slope (% grade)	range: 0 to 12 $\bar{x}$ = 4.412 s = 2.091	range: 0 to 50 $\bar{x}$ = 6.643 s = 9.952	range: 0 to 70 $\bar{x}$ = 9.941 s = 13.16
Vertical relief within ½ km radius (feet)	range: 40 to 530 $\bar{x}$ = 228.853 s = 127.426	range: 25 to 460 $\bar{x}$ = 134.449 s = 82.154	range: 20 to 780 $\bar{x}$ = 175.838 s = 133.785
Exposure (degrees)	range: 10 to 180 $\bar{x}$ = 98.455 s = 54.124	range: 1 to 179 $\bar{x}$ = 104.918 s = 48.445	range: 0 to 178 $\bar{x}$ = 84.676 s = 53.959
Distance to vantage point (meters)	range: 0 to 1.8 km $\bar{x}$ = 368 s = 419	range: 0 to 2.15 km $\bar{x}$ = 693 s = 607	range: 0 to 3.4 km $\bar{x}$ = 973 s = 963
Viewspread (degrees)	range: 50 to 360 $\bar{x}$ = 243.088 s = 86.11	range: 15 to 360 $\bar{x}$ = 218.163 s = 98.167	range: 25 to 360 $\bar{x}$ = 188.603 s = 89.321
Distance to juniper area (km)	range: 0 to 15.8 $\bar{x}$ = 2.232 s = 4.775	range: 0 to 9.2 $\bar{x}$ = 4.399 s = 2.964	range: 0 to 21.8 $\bar{x}$ = 8.734 s = 6.062
Elevation (feet)	range: 4940 to 6040 $\bar{x}$ = 5670.588 s = 285.466	range: 4780 to 5850 $\bar{x}$ = 5178.776 ---	range: 4810 to 5960 $\bar{x}$ = 5345.588 s = 288.813

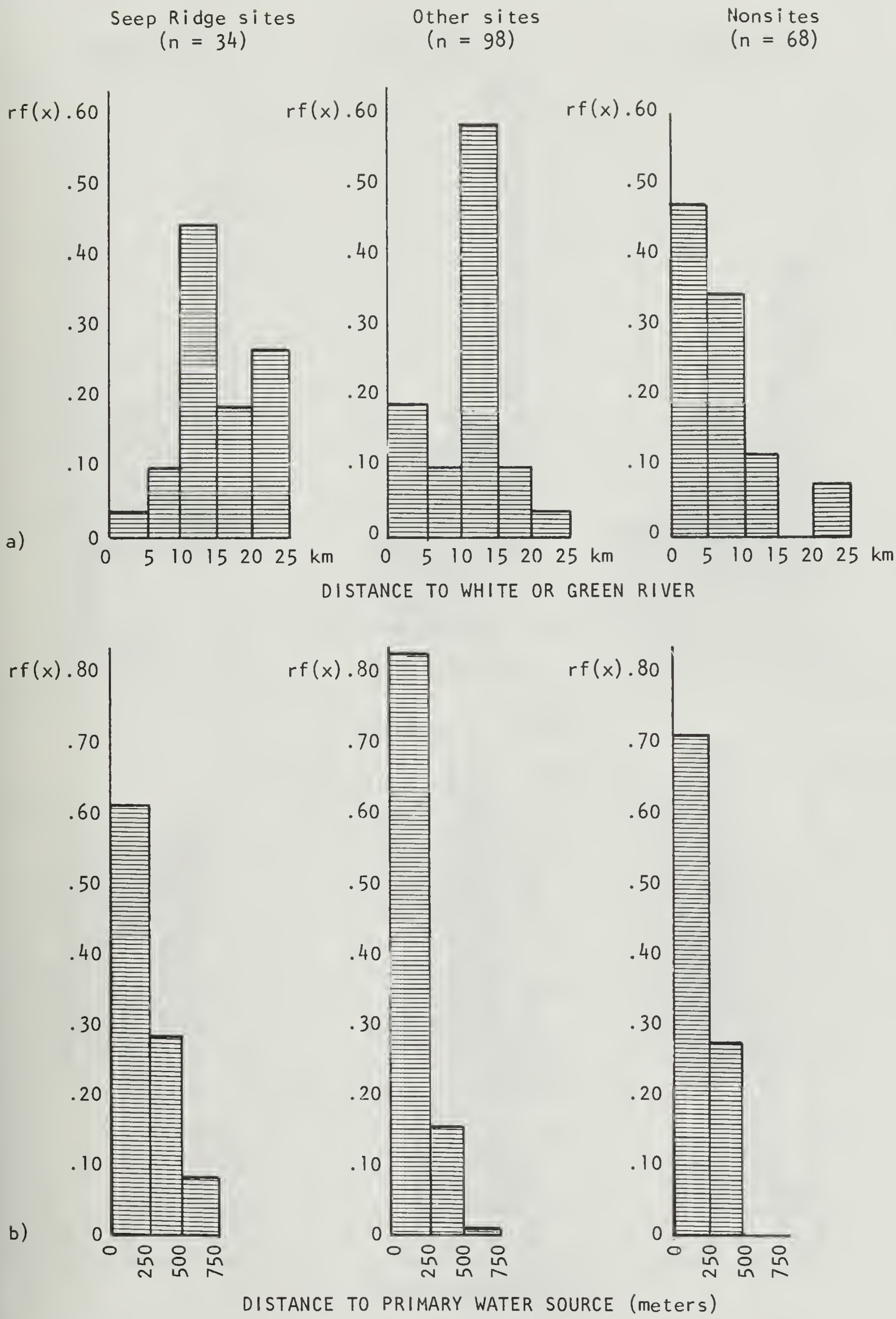


Figure 52. Comparative distributions of distances to a) White or Green Rivers and b) primary water source.

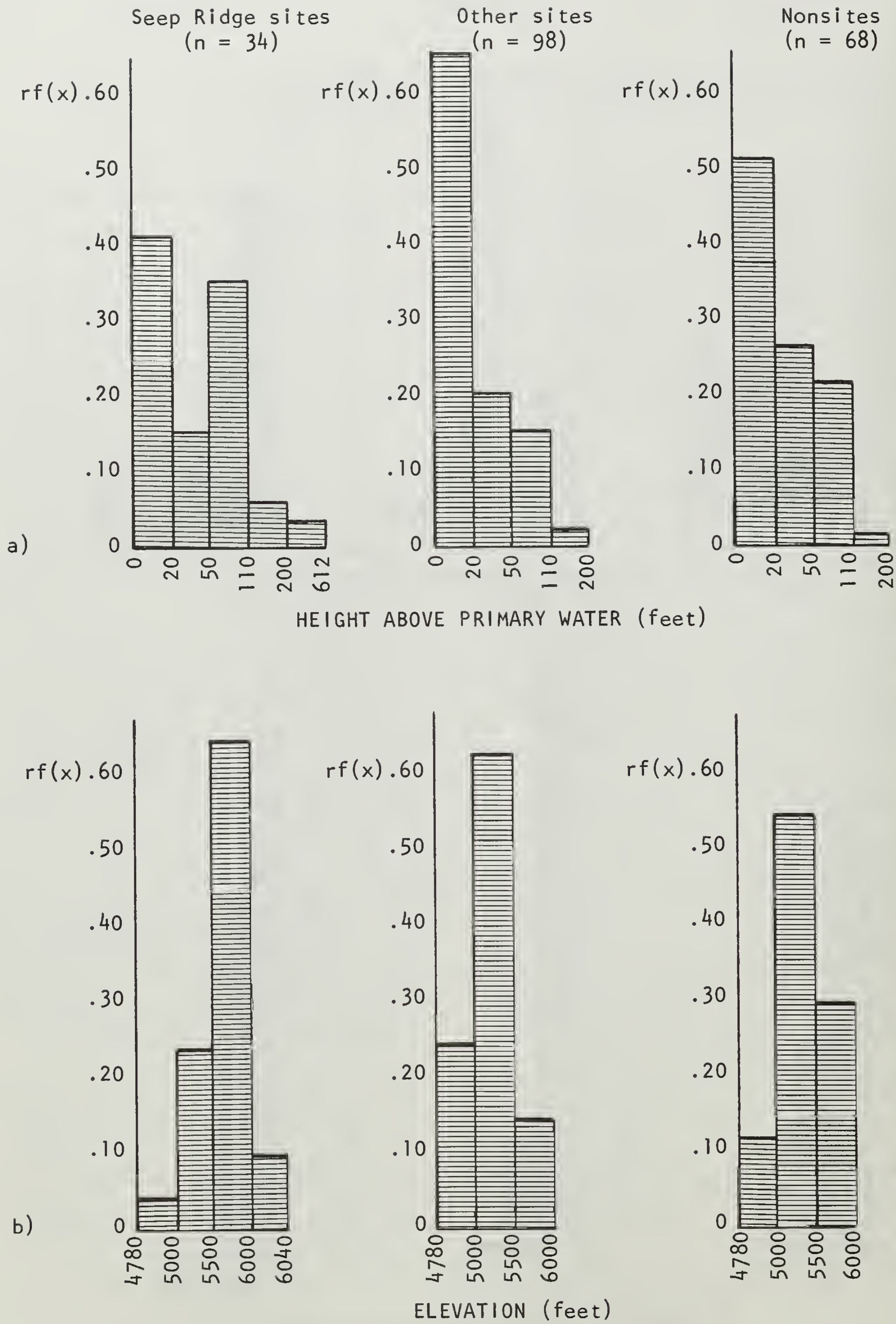


Figure 53. Comparative distributions of a) height above primary water and b) elevation.

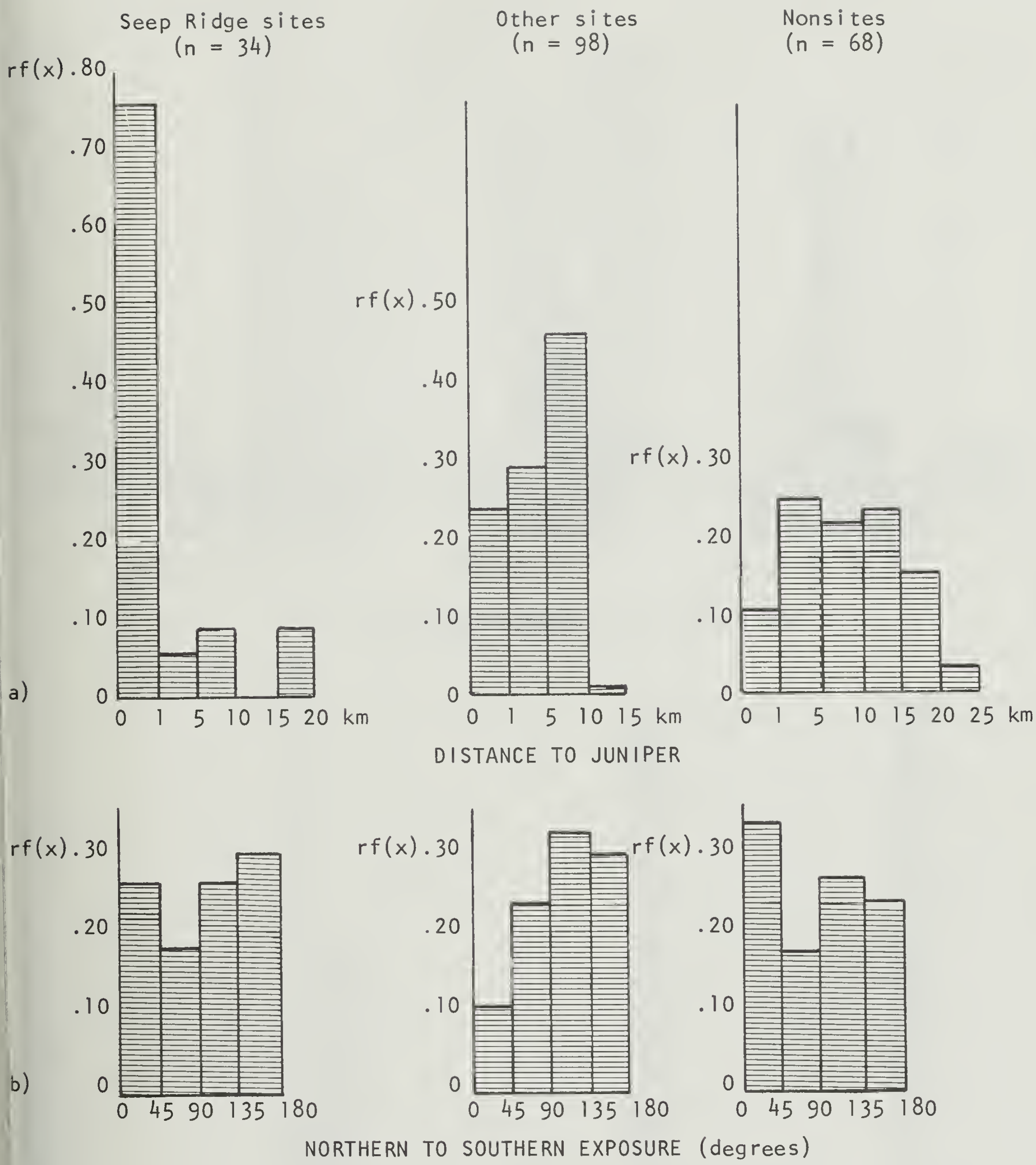


Figure 54. Comparative distributions of a) distance to juniper, and b) northern to southern exposure.

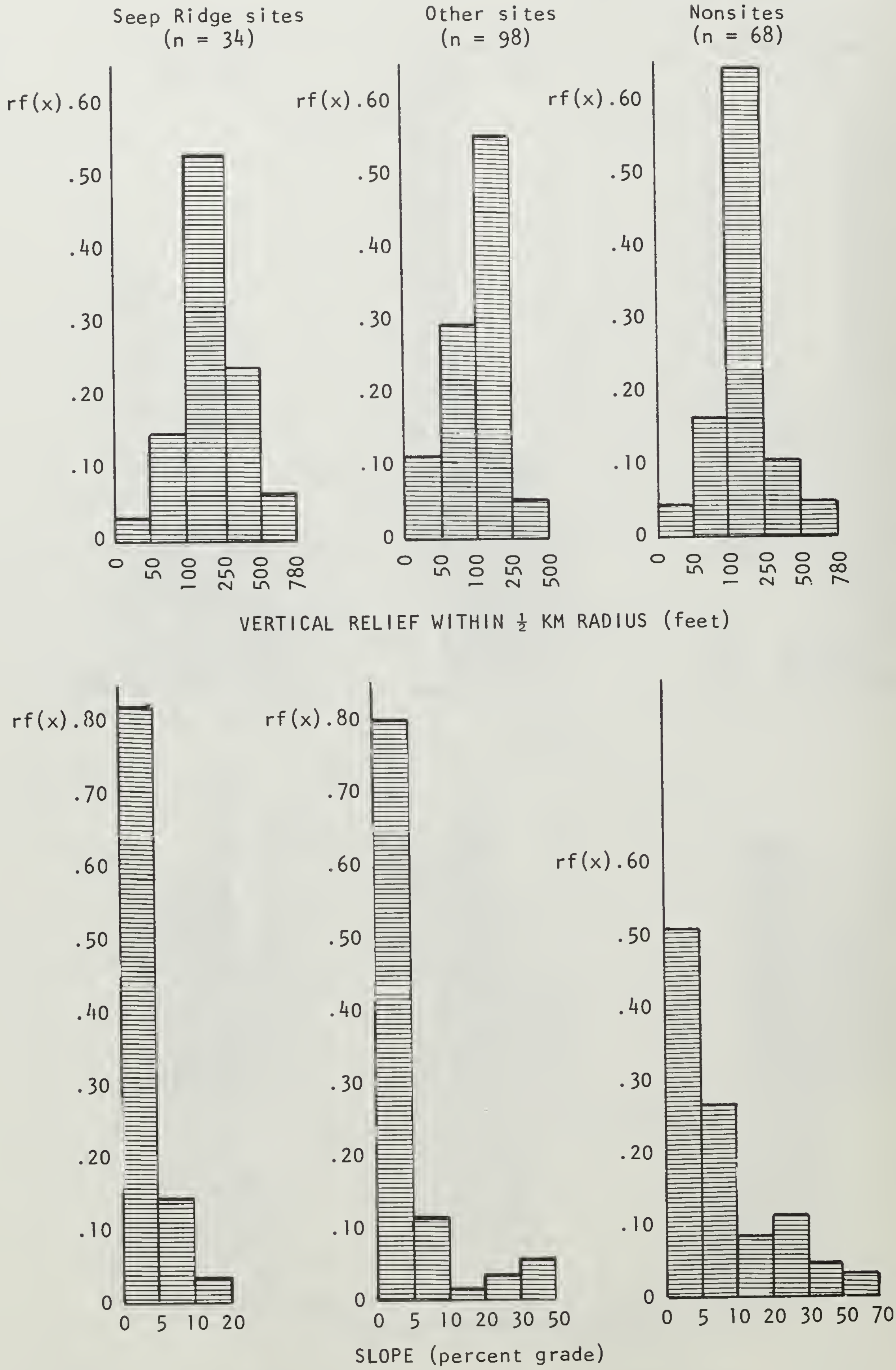


Figure 55. Comparative distributions of a) vertical relief, and b) slope.

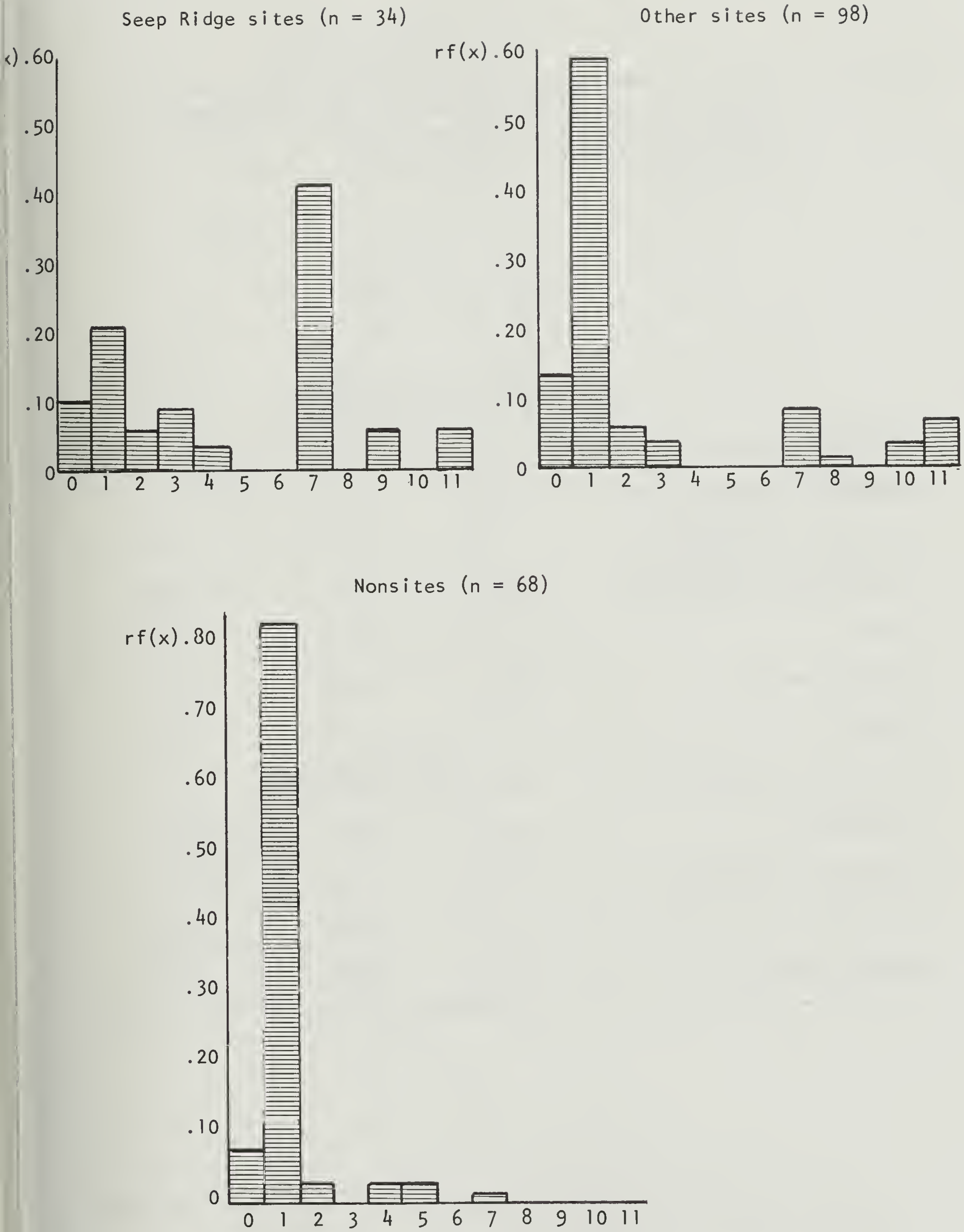


Figure 56. Comparative distributions of rank of shelter quality.

Table 17. Results of Komologorov-Smirnov Two-Sample tests. Numbers indicate the two-tailed probability (p) that the two samples were drawn from the same population distribution. Significant values of p are underlined.

Variable	Seep Ridge sites versus other sites	Seep Ridge sites versus nonsites	other sites versus nonsites
Distance to nearest river	.004	.000	0
Distance to primary water	.073	.711	.568
Height above primary water	.019	.162	.338
Slope	.285	.017	.003
Vertical relief	.000	.001	.036
Exposure	.676	.228	.023
Distance to vantage point	.017	.003	.217
Viewspread	.395	.004	.062
Distance to juniper	.000	0	.000
Elevation	0	.000	.000
Shelter quality	.000	.000	.082

	Area vegetation same	Area vegetation different	
Seep Ridge sites	14	20	34
other sites	52	46	98
	66	66	132

$x^2 = 1.4$
d.f. - 1
$.3 < p < .2$

	Area vegetation same	Area vegetation different	
Seep Ridge sites	14	20	34
nonsites	44	24	68
	58	44	102

$x^2 = 5.05$
d.f. = 1
$.05 < p < .02$
C = 0.217

	Area vegetation same	Area vegetation different	
other sites	52	46	98
nonsites	44	24	68
	96	70	166

$x^2 = 2.26$
d.f. = 1
$.2 < p < .1$

Figure 57. Chi-square (x^2) analyses of comparative distributions of sites and nonsites with respect to "ecotone" variable.

d.f. = degrees of freedom
p = probability that distribution is random
C = contingency coefficient

	Juniper	Saltdesert	Other	
Seep Ridge Sites	25	7	2	34
other sites	14	64	20	98
	39	71	22	132

$x^2 = 42.9$
d.f. = 2
$p < .001$
C = 0.495

	Juniper	Saltdesert	Other	
Seep Ridge sites	25	7	2	34
nonsites	1	52	15	68
	26	59	17	102

$x^2 = 70.8$
d.f. = 2
$p < .001$
C = 0.64

	Juniper	Saltdesert	Other	
other sites	14	64	20	98
nonsites	1	52	15	68
	15	116	35	166

$x^2 = 7.97$
d.f. = 2
$.02 < p < .01$
C = 0.214

Figure 58. Chi-squar↑ (x^2) analyses of comparative distributions of on-site .egetation.

d.f. = degrees of freedom
p = probability that distribution is random
C = contingency coefficient

	Seep Ridge sites	other sites	
Dunes Present	21	46	67
Dunes Absent	13	52	65
	34	98	132

$x^2 = 2.17$
d.f. = 1
$.2 < p < .1$
$C = 0.127$

	Seep Ridge sites	nonsites	
Dunes Present	21	5	26
Dunes Absent	13	63	76
	34	68	102

$x^2 = 35.31$
d.f. = 1
$p < .001$
$C = 0.507$

	other sites	nonsites	
Dunes Present	46	5	51
Dunes Absent	52	63	115
	98	68	166

$x^2 = 29.59$
d.f. = 1
$p < .001$
$C = 0.389$

Figure 59. Chi-square (x^2) analyses of comparative distributions of sand dunes.

d.f. = degrees of freedom
p = probability that distribution is random
C = contingency coefficient

than the other sites. The distribution of sites and nonsites with respect to vertical and horizontal distances from primary water sources is similar, although Seep Ridge sites are at significantly greater distances than are the other sites. It must be concluded that the classification of intermittent drainages as primary water sources must not be valid for this region, or that intermittent drainages are numerous and widespread enough throughout the region that location with respect to water sources was not a critical factor influencing settlement. The former explanation is considered to be more plausible than the latter.

Floral Resources

Both sets of sites are closer to juniper areas than are nonsites; Seep Ridge sites are markedly closer to juniper than are the other sites. In addition, juniper is the dominant vegetation at 73.5% of the Seep Ridge sites, as compared to 14.3% of the other sites and only 1.5% of the nonsites.

A significantly higher percentage of Seep Ridge sites (61.8%) and other sites (46.9%) is associated with sand dunes than are nonsites (7.4% on dunes).

The vegetation on Seep Ridge sites differs from the surrounding vegetation more often than either the other sites or the nonsites. This is probably a reflection of the location of Seep Ridge sites in isolated stands of juniper.

Topographic Situation

Fifty percent of Seep Ridge sites are located on ridge tops or knolls, 20.6% are on floodplains, and the remainder are located on flats (8.8%), benches (5.9%), slopes (11.8%), or canyon rims (2.9%). In comparison, only 28.6% of the other sites are located on ridge tops or knolls, with 30.6% being on flats, 12.2% on floodplains, 16.3% on benches or terraces, and the remaining 12.2% on saddles, slopes, canyon rims, or mesas. Nonsites are predominantly located on floodplains (30.9%), with 20.6% situated on slopes, 17.6% on flats, 16.2% on benches, and 14.7% on ridge tops or knolls. The significance of this observed distribution cannot be assessed without calculating the acreage represented by each of the landform categories in the region.

However, other landform attributes indicate that the topographic situation of sites is nonrandom. As was expected, both sets of sites are located on more gentle slopes than are nonsite points. The relatively high percentage of Seep Ridge sites located on ridges and knolls is reflected by significantly greater values of local relief within ½ km radius when compared to the other sites or to the nonsites. In contrast, the other sites have significantly <u>less</u> local relief than do nonsites.

Seep Ridge sites are closer to points of vantage than either the other sites or the nonsites. Other sites are also significantly closer to vantage points than are nonsites.

Elevations are highest for the Seep Ridge sites and lowest for the other sites in the region. Nonsites fall in between the two extremes. This variable is not, however, considered to be of great importance to the analysis.

Seep Ridge site loci, due to their association with juniper forests, possess a higher rank of shelter quality (mode = 7) than do the other sites (mode = 1) or the nonsites (mode = 1).

Summary

It is obvious from the above analyses of individual factors influencing site location in northeastern Utah that no single environmental variable emerges as a reliable predictor of site presence. Rather, what might appear to be a critical determinant of Seep Ridge site location (e.g., proximity to a vantage point) does not prove to hold true with regard to the location of other sites in the region, even though several of the other sites are located within the boundaries of the Seep Ridge project area. Similarly, the presence of juniper or of sand dunes characterizes a large number of sites but does not explain the absence of sites in other loci where juniper and dunes are also present. Clearly, an analysis of the multivariate relationships of environmental attributes influencing site location is called for.

The Predictive Model of Site Location

Introduction to Discriminant Function Analysis

Discriminant function analysis has, in recent years (coincident with its availability as a "canned" computer program in the Statistical Package for the Social Sciences [Nie et al. 1975] and the Biomedical Computer Programs [Dixon 1975]), become a popular analytical tool for archaeologists wishing to explore the multivariate differences between two or more sets of items. This statistical technique has been successfully applied to the analysis of technological differences between groups of stone tools (Chandler and Ware 1977; Smith and Goodyear 1977) and to the analysis of locational differences between different site types (Brown 1979) or between site and nonsite loci (Chase and Jennings 1978; Holmer 1979; Kvamme 1980).

Discriminant function analysis (after Klecka 1975:435-436) can be described as a multivariate technique for statistically distinguishing between two or more groups of cases. As mentioned in the examples given above, such groups of cases might be artifacts, sites, or any other data sets defined by a particular research situation. A number of discriminating variables measuring attributes between which the groups are expected to differ are selected by the researcher. These variables are then mathematically combined and weighted in such a manner that within-group variation of discriminant attributes is minimized and between-group variation is maximized; in other words, the groups are "forced" to be

as statistically distinct as possible. This is accomplished, in a two-group situation, by forming a linear combination of discriminating variables--a discriminant function on which cases from one group are clustered at one end and cases from the second group are clustered at the opposite end. The discriminant function is of the form

$$D_i = d_{i1}Z_1 + d_{i2}Z_2 + \ldots + d_{ip}Z_p$$

where D_i is the score on discriminant function i, the d's are weighting coefficients, and the Z's are the standardized values of the p discriminating variables used in the analysis. Importantly, the weighting coefficients can be interpreted much as in multiple regression or factor analysis and thus serve to identify the variables which contribute most to between-group differentiations.

A stepwise procedure can be utilized to select only the discriminating variables which are most useful in distinguishing between groups. Since it is often the case that a researcher does not know, prior to the analysis, which variables are the best discriminators, more variables than may be necessary to achieve satisfactory discrimination are initially entered into the analysis. The stepwise procedure begins by selecting the single best discriminating variable on the basis of a statistical criterion set by the researcher (e.g., largest increase in the generalized distance between groups as measured by Rao's V). The second discriminating variable is selected as the variable which, <u>in combination with the first variable</u>, is best able to statistically increase the distance between the groups. Subsequent variables are similarly selected on the basis of their ability to contribute to further discrimination. At each step of the analysis, selected variables may be removed if they are found to reduce discrimination when combined with more recently selected variables. When all variables have been selected or--as is more likely--when it is found that the remaining variables no longer contribute significantly to further discrimination, the stepwise procedure ceases and further analysis is performed using only the best discriminating variables. The researcher is thus provided with a set of attributes between which the groups under study are best differentiated. The results of this stage of the analysis alone can be of major theoretical significance.

However, discriminant function analysis can be further used as a classificatory technique. After a set of variables providing satisfactory discrimination between cases of known group affiliation is found, the discriminant function can be employed to classify cases of unknown group affiliation. Thus, for example, if environmental attributes which are successful at predicting the presence of known site loci are found, these same attributes can be used to predict the likelihood that sites will be present at loci which have not been field-checked. Before unknown cases are classified, the discriminating power of the linear function can be ascertained by independently classifying the original set of cases to see how many are correctly classified by the discriminating variables. The procedure for classification involves the use of a separate linear combination of the variables for each group, which produces a probability of membership in the respective group. The case is assigned to the group with the highest probability.

The Seep Ridge Example

The research design for the development of a predictive model of site location for the Bonanza Planning Unit is centered around discriminant function analysis of site and nonsite loci. As originally conceived, a set of discriminating variables would be derived from the analysis of the environmental attributes of 34 prehistoric sites and 68 nonsite loci recorded on the Seep Ridge Project. The ability of the resultant discriminant function to correctly classify loci as sites would be checked by the classification of 98 prehistoric sites located within the regional project area. As will be discussed in more detail below, a modification of this approach was required before site loci could be correctly identified throughout the Bonanza Planning Unit. A discriminant function was instead derived utilizing the discriminating environmental variables measured on the 68 nonsite loci and on the group of 98 "other" sites. This second function proved best able to classify both Seep Ridge sites and the other sites in the project area.

Seep Ridge data

The original discriminant function analysis focused on the Seep Ridge sites and nonsites. The following ten variables were input as discriminating variables in a stepwise analysis, with an increase of 2.7 in Rao's V set as the criterion for inclusion in the analysis:

VANTAGE - distance to vantage point
VIEW - viewspread
EXPOSURE - 0 to 180° exposure
HEIGHT - height above primary water source
RELIEF - vertical relief within $\frac{1}{2}$ km radius
SHELTER - shelter quality
SLOPE - percent grade
WOOD - distance to juniper forest
SAND - presence or absence of sand dunes
ECOTONE - site vegetation compared to surrounding vegetation

Five variables were selected by the stepwise procedure as the best discriminators between Seep Ridge site and nonsite loci. On the basis of the magnitude of the standardized discriminant function coefficients (i.e., the weighting coefficients of the linear function), the variables can be ranked according to their contribution toward between-group differentiation as follows:

1)	SHELTER	.63771
2)	WOOD	-.56443
3)	SAND	.47401
4)	VANTAGE	-.46193
5)	VIEW	.33733

The sign of the coefficient indicates whether a high or low value of that variable contributes toward a discriminant score which would classify a given case as a site or as a nonsite. For this particular

function, high positive values are indicative of site loci; therefore, high values of shelter quality, viewspread, and sand dunes and low values of distances to juniper and vantage point contribute toward a case's classification as a site.

When applied to the classification of the Seep Ridge data from which the discriminant function had been derived, the group membership of 82.4% (28 of 34) of the sites and 95.6% (65 of 68) of the nonsites was predicted accurately--a combined total of 91.2% correct classifications. This discriminant function, however, did not provide satisfactory results when used to predict the presence of the other 98 known sites. Forty-six of the latter group were incorrectly classified as nonsites. This poor showing appears to be due to lower values of the other sites for shelter quality and viewspread, and greater distances to juniper and vantage points. As was described in the preceding section, the univariate distributions of each of these environmental attributes differ significantly between Seep Ridge sites and the other sites in the project area, with the mean values of the other sites for these variables being closer to nonsite means than are the Seep Ridge means. The two groups of sites do not differ significantly with regard to the presence of sand dunes, however.

Because the Seep Ridge sites thus seem to occupy a more extreme--and apparently more optimal--environmental situation when compared to nonsites than do the other sites in the project area, a second discriminant analysis was performed, using the nonsite and other site data.

Nonsite and Other Site data

The discriminant analysis of nonsite and other site data was not ideal due to the restricted distribution of nonsite loci to the Seep Ridge project area as compared to the distribution of sites throughout the Bonanza Planning Unit, as well as the smaller number of nonsites ($n = 68$) as compared to sites ($n = 98$). Neither of these drawbacks appears to have seriously impaired the analysis, however.

The same ten discriminating variables as were used in the original discriminant function analysis were input, and an eleventh variable was added. RIVER: distance to either the White or Green River, was originally omitted because, since sites tend to be located at greater distances to a river than do nonsites, the variable was not considered to be a useful discriminator. It was included in the second analysis on a trial basis.

The stepwise procedure--utilizing the same criterion for selection as noted above--selected eight of the eleven discriminating variables for inclusion in the discriminant analysis. The resultant discriminant function possesses a canonical correlation of .727, indicating that 53% of the variance in the data set is explained by the function. On the basis of the standardized canonical discriminant function coefficients, the variables can be ranked according to their discriminating power as follows:

1) SAND -.73654
2) VANTAGE .69585
3) WOOD .69112
4) RELIEF .39179
5) SHELTER -.30976
6) EXPOSURE -.28973
7) VIEW -.23447
8) ECOTONE .20176

The presence of dunes and low distance values to juniper and vantage points are the major factors contributing toward the correct classification of a given locus as a site. High values of shelter quality, exposure and viewspread, low vertical relief, and homogeneous vegetation also contribute toward the identification of site loci (Appendix 9).

This discriminant function was able to accurately classify 88% of the cases on which the analysis was performed, including 85.3% (58 of 68) of the nonsites and 89.8% (88 of 98) of the sites. Somewhat surprisingly, when the function was applied toward the prediction of site or nonsite group membership of the 34 Seep Ridge sites, only one site was misclassified: an accuracy rate of 97.1%. The success of the discriminant function is undoubtedly due, as has been discussed above, to the extreme values of the Seep Ridge sites for the discriminating variables.

The unstandardized discriminant function equation derived from this analysis is:

$$D_i = .90029(\text{distance to vantage}) - .00248(\text{viewspread}) - .00571(\text{exposure}) + .00368(\text{vertical relief}) - .11525(\text{shelter quality}) + .15372(\text{distance to juniper}) - 1.7503(\text{presence of dunes}) + .42858(\text{homogeneity of vegetation}) - .53056$$

Discriminant scores (D_i) less than +0.193445 indicate the presence of a site; scores higher than this number indicate the absence of a site (i.e., a "nonsite"). The probability that a given locus contains a site can be computed by the formula:

$$p(s/d) = \underline{e}^{-0.5 \times (d_i - (-0.87695))^2} \Big/ \left(\underline{e}^{-0.5 \times (d_i - (-0.87695))^2} + \underline{e}^{-0.5 \times (d_i - 1.26384)^2}\right)$$

where d_i is the discriminant score of the locus to be classified, -0.87695 is the group mean (centroid) of the sites on the discriminant axis, 1.26384 is the group centroid of the nonsites, and e is the natural log of the computed numbers.

For example, site 42UN725 has the following values for the discriminating variables:

VANTAGE	0.4 km
VIEW	360°
EXPOSURE	96°
RELIEF	90 ft
SHELTER	0
WOOD	7.0 km
SAND	1 (present)
ECOTONE	0 (site vegetation = area vegetation)

Multiplying the value of each variable by its weighting coefficient and subtracting the constant 0.53056 from the sum of the products results in a discriminant score of -1.9544. Since this value falls below the dividing point between sites and nonsites, 42UN725 is correctly classified as a site. The discriminant score of -1.9544 results in a probability of .99 that 42UN725 belongs to the site group.

Because this discriminant function incorporates information about the vegetation and the presence of sand dunes at a particular locus, it was feared that it would have limited utility for management purposes until such time that a map detailing vegetational communities and sand dune location is available. Consequently, a discriminant analysis of the nonsite and site data omitting these two field-measured variables (SAND and ECOTONE) was attempted. The nine discriminating variables input into the final analysis can each be measured for any given point on U.S.G.S. topographic maps (Appendix 10).

The stepwise discriminant analysis included six discriminating variables. Five of these variables were the same as those selected as the best discriminators in the preceding analysis; however, RIVER was selected above SHELTER in the modified function. The variables are ranked according to their standardized canonical discriminant function coefficients as follows:

1)	VANTAGE	-.83741
2)	WOOD	-.66303
3)	RELIEF	-.46968
4)	RIVER	.40004
5)	EXPOSURE	.35276
6)	VIEW	.28187

Once again, low distance values to juniper and to a vantage point contribute significantly toward classification of a given locus as a site. Low values for vertical relief within $\frac{1}{2}$ km radius and high values of distance to the White or Green River, exposure, and viewspread are also factors which contribute toward the identification of site loci.

Not surprisingly, given the importance of the presence of sand dunes as a site versus nonsite discriminator, the discriminating power of this latter function is less than the function which includes data on sand dune presence. The canonical correlation of the discriminant function is reduced to .633, indicating that 40% of the variance in the data set is explained by the function. Nonetheless, the discriminant function was still relatively successful at correctly predicting group

membership of sites and nonsites, with an increase in misclassification of four additional nonsites (54 of 68, or 79.4% correctly classified), two additional sites (86 of 98, or 87.8% correctly classified), and two additional Seep Ridge sites (31 of 34, or 91.2% correctly classified).

The discriminant equation derived from this analysis is:

$$D_i = .00298(\text{viewspread}) - 1.08345(\text{distance to vantage}) + .00695(\text{exposure}) + .07303(\text{distance to river}) - .00442(\text{vertical relief}) - .14748(\text{distance to juniper}) + .48296$$

Sites possess discriminant scores greater than -0.14928, and nonsites have scores smaller than this number. The probability that a given locus belongs to the site group can be calculated using the formula:

$$p(s/d) = \underline{e}^{-0.5 \times (d_i - 0.67675)^2} \Big/ \left(\underline{e}^{-0.5 \times (d_i - 0.67675)^2} + \underline{e}^{-0.5 \times (d_i - (-0.97531))^2}\right)$$

where d_i is the discriminant score of the locus in question, 0.67675 is the centroid of the site group, -0.97531 is the centroid of the nonsite group, and e is the natural logarithm of the computed numbers.

Using the example of 42UN725 again, the same values of viewspread, vantage distance, exposure, vertical relief, and distance to wood would be used in the calculations. The distance to the river is 12.4 km. Multiplying by the new weighting coefficients and adding the products to the new constant of 0.48296 results in a discriminant score of 1.265. Since this value lies above the dividing point between sites and nonsites, 42UN725 is again correctly classified as a site. The attendant probability of its membership in the site group is .912.

Summary

To summarize, discriminant function analysis has identified the environmental factors which best distinguish between locales in northeastern Utah where sites are known to be present and those at which sites are known to be absent. The information gained from this analysis provides us with insights as to the site location strategy of prehistoric hunter-gatherers in the region. The fact that multiple discriminating variables are required to distinguish between site and nonsite loci once again brings out the importance of examining the interrelationship of environmental attributes and their combined effect upon site location. Sensitivity maps drawn on the basis of single variables--important though each might be--overlook the contribution of other factors to site locational strategy.

The discriminant function analysis which is best able to "predict" whether or not known loci contain sites incorporates eight variables. Loci which are characterized by the presence of sand dunes, a high

shelter quality, southerly exposure, a wide viewspread, low vertical relief, homogeneous vegetation, and which are in close proximity to a vantage point and to a juniper area have high probabilities for site occurrence. When point-specific vegetational and sand dune data are omitted from the analysis, six environmental variables are incorporated into a discriminant function which is still able to classify known loci as sites or nonsites with a high degree of accuracy. This function is also changed from the previous one by the substitution of distance from a river for high shelter quality in the group of best discriminating variables. Since all six variables can be measured on U.S.G.S. topographic maps, the use of the discriminant equation to predict site location is considered to be a potentially powerful management tool. For example, given the location of a proposed well pad, a cultural resource manager could measure the distance from that locus to a point of vantage, the distance to juniper, the distance to the nearest river, the vertical relief within ½ km radius, the exposure, and the viewspread. These figures could then be "plugged into" the discriminant equation, and a discriminant score calculated. The probability that the well pad location contains a prehistoric site could then be computed. If the probability of site presence is low, archaeological clearance could be granted without the necessity of a field check. If, however, the probability of site presence is near the 50% range, a field inventory would be in order. An extremely high probability value would require on-site inspection of the proposed impact area. It should be noted that the current discriminant function tends to err in the direction of misclassification of nonsite loci as sites. From the standpoint of cultural resource protection, this type of error is certainly preferable to misclassification of sites as nonsites.

It must be stressed, however, that the results presented here are intended to serve primarily as an example of the predictive power of this technique. The use of this particular discriminant equation to predict site locations in the Bonanza Planning Unit is not recommended until the function is strengthened by the inclusion of more data. In particular, the nonsite group should be augmented by data about many more loci where sites are known to be absent in the project area. Since many square miles of terrain which have been intensively surveyed have been found to be devoid of prehistoric sites, hundreds of nonsite loci could easily be added to the data base. The inclusion of more negative data would allow for the derivation of a function with greater discriminating power in comparison to the function derived from the analysis of only 68 nonsites. Furthermore, the relationship between sites and water resources does not appear to have been explored well by the water-related variables measured in this analysis. No significant differences were found between sites and nonsites with regard to horizontal or vertical distance to what had been considered primary water sources--the blue-line intermittent drainages. The myriad number of these ephemeral streams and their location throughout the project area evidently allows for their close proximity to any given point. On the other hand, the distances to the major rivers are so great that, overall, sites are significantly farther from these permanent sources of water than are nonsites. The addition of a variable measuring distances to major, named intermittent streams (e.g., Kennedy Wash, Coyote Wash, K Creek) may indicate site patterning with respect to these larger drainages.

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

Summary

A sample-oriented cultural resource inventory of the 109,440 acre Seep Ridge study tract in Uintah County, northeastern Utah, was undertaken to identify evidence of past use of the area. Intensive survey of 274 randomly-selected 40-acre sample units (adding up to 17.1 square miles, or 10% of the total area) resulted in the recording of 41 sites, 40 of which were located in sample units. Thirty-four of the sites have prehistoric components; seven are Euro-American sites. Extrapolating from a site density of 2.34 sites per square mile in 10% of the study tract, a total of 400 sites is estimated to be present in the tract as a whole.

The study tract is environmentally diverse. It includes portions of topographic and biological features of several previous surveys, ranging from a riparian zone along the White River to eroded buttes capped by sandstone outcroppings to sand dune fields and clay badlands. It also includes sage-covered benches and basins, and two high parallel ridges with juniper growth on their slopes and foothills. Prehistoric site distribution shows marked similarities to that of previous surveys (Hauck et al. 1979; Holmer 1979; Chandler and Nickens 1979a, 1979b; Larralde and Nickens 1980) in preference for juniper, sand dunes, and rock outcroppings. An unexpected dissimilarity is that no sites were found along the White River. Evidence that Paleo-Indian, Archaic, Fremont, and probably Shoshonean groups utilized the area was found, but use patterns appear to be sporadic. Sites are short-term campsites or limited activity areas, with few signs of regular or long-term occupation.

Seasonal use of the study tract is suggested. The tract may have been used even less regularly, perhaps only in years of relative abundance or relative scarcity elsewhere. Sites cluster on sand dunes and on Raven Ridge and Squaw Ridge and their foothills. Dunes offer early summer seed crops, including *Oryzopsis*. The ridges constitute apparently the most attractive concentration of resources in the study tract, including not only dune plants but also excellent vantage for game observation. A model of vegetable food procurement on sand dunes and faunal resource procurement along the river as suggested by previous work in the area can be modified to concentrate on the ridges as a resource base.

In Chapter 5 a discriminant function analysis identified specific attributes that contribute to site location. Two of the most important attributes have been used to define sensitivity zones reflecting high, medium, and low site density in the study tract. The high zone is based on presence of juniper and covers approximately 16.6% of the tract. Site density in this zone is 6.54 per square mile. The medium zone includes 24.7% of the tract, with a site density of 1.52 per square mile. This zone encompasses parts of the tract where dunes are present without juniper. The remaining 58.8% of the tract is characterized by absence of dunes and juniper. Site density in this low sensitivity zone is .68

per square mile. Some adjustments were made in definition of lands included in each zone, to reflect site distribution in this and previous surveys. The riparian strip along the White River was included in the high sensitivity zone, based on results of Berry and Berry's (1976) survey which reported high riverine site densities adjacent to the Seep Ridge tract. "Buffer areas" along Coyote Wash and surrounding juniper growth were included respectively in the medium and high zones to more accurately reflect dune and site location. It should be noted that the medium sensitivity zone is based on presence of sand dunes as defined by field observation; more accurate information may change the parameters of this zone.

National Register Considerations

In order to enable the Bureau of Land Management to make cultural resource decisions about recorded sites, archaeologists are required to assess site significance. Criteria for significance are the guidelines for placing sites on the National Register of Historic Places. As written in the U.S. Government Code of Federal Regulations (36 CFR 60), the criteria are described as follows:

> National Register criteria for evaluation. The quality of significance in American history, architecture, archeology, and culture is present in districts, sites, buildings, structures, and objects of State and local importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and
>
> (a) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) That are associated with the lives of persons significant in our past; or
>
> (c) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) That have yielded, or may be likely to yield, information important in prehistory or history.

Prehistoric sites are usually evaluated in terms of their potential for yielding information important to prehistory. Historic sites lacking association with individuals are examined in terms of their place in the broad patterns of American history. Of the 41 sites recorded during the Seep Ridge Project, seven are judged to be eligible for nomination to the National Register, based on the above criteria. The remaining 34 sites are not considered eligible. These sites are believed to have little or no depth of deposits; they lack diagnostic artifacts and/or features;

and in some cases have been disturbed by vandalism or construction activities. For these reasons, they probably will yield little data important to area history or prehistory.

Reasoning for considering the remaining seven sites eligible for National Register nomination follows.

42UN918: This site is a large prehistoric campsite with abundant burned rock, ground stone, and one diagnostic projectile point indicative of Archaic, Fremont, or Shoshonean occupation. A charcoal lens was located approximately 1 meter below the surface in the wall of an eroding arroyo. These factors make it likely that the site, located on a dune in Coyote Basin, has potential to yield information important to understanding dune settlement patterns. The site is considered eligible for National Register nomination. We further recommend that testing or limited excavation be conducted at this site before its integrity is lost due to erosion.

42UN919 is a large lithic scatter with an Archaic component and a Fremont or Shoshonean component. A high proportion of tools to flakes characterizes the surface artifact distribution. The probable presence of at least two components, location near a dune in Coyote Basin, and likelihood of depth all contribute to the site's potential for yielding information important to area prehistory.

42UN931 is a large campsite with several hearths, a rockshelter, Fremont ceramics, and a Desert Side Notched projectile point. The site is located in juniper growth north of the White River. Although vandals have disturbed the site, we believe that it retains potential for yielding information about seasonal Fremont occupation of the area and we consider it eligible for nomination to the National Register.

42UN939 is a large dune campsite with abundant ground stone, at least two hearths, a projectile point or biface possibly indicative of Fremont occupation, and a dense cover of tools and utilized flakes. The site appears to have depth. For these reasons, it is considered to be eligible for National Register nomination.

42UN942 is a small campsite located on Squaw Ridge. Two diagnostic projectile points indicating Fremont or Shoshonean occupation, burned bone, and a hearth area are present. Depth is indicated by a large number of retouched flakes on an anthill. The site's location in this high site density area adds to its potential for yielding information important to area prehistory.

42UN949 is a masonry structure located adjacent to the Cowboy Gilsonite Vein. Although in a state of deterioration, parts of the site are still structurally sound and a large amount of historic trash is present. The structure once housed prospectors who staked this

productive vein. The site is thus associated with early events of an industry, gilsonite mining, that has been important in shaping the history of the Uintah Basin, and is eligible for nomination to the National Register.

42UN954 is a large prehistoric campsite with at least 17 hearths and Fremont ceramics. It is located on the foothills of Squaw Ridge and has potential for yielding information about Fremont use of the ridge system. The site is eligible for nomination to the National Register.

Management Recommendations

Since the survey sample was not based on a stratified design, sensitivity zones could be constructed from field observations of environmental variables and from site densities. No modification of the sampling design was necessary. Recommendations for project-specific cultural resource clearances in each of the three zones are as follows. Field inspections by archaeologists should continue in the high and medium sensitivity zones. The high zone can be easily identified by presence of juniper or riparian vegetation as marked on U.S.G.S. quads, with a surrounding one kilometer buffer area. Raven and Squaw Ridges appear to have a particularly high incidence of cultural resources; this point should be considered in any plans for future development of the area.

The medium zone has been defined by presence of sand dunes. As noted above, this definition could be enhanced by more specific data on dune location. All sites in this zone are located on dunes. Thus, although we recommend in an overall sense that the requirement for cultural resource inspection continue in the medium zone on a site-by-site basis, it might be further possible to define additional culturally vacant areas within this zone, i.e. areas without dunes. Further work along these lines could be undertaken by BLM. In the meantime, developers could be required to avoid areas of stabilized dunes. Although few sites were recorded in this zone during the Seep Ridge survey, previous surveys (cf. Chandler and Nickens 1979b) suggest relatively high site densities in similar areas.

The low sensitivity zone seems to be characterized by vast tracts of lands nearly void of cultural resources. It should be taken into consideration, however, that two of the three sites recorded in this zone were associated with rock outcroppings or bluffs on vantage points discernible from a U.S.G.S. quad and are located on either side of a small drainage. Given the anomalous nature of these two site locations and the apparent emptiness of the rest of the zone, we recommend that it would still be well to stress to developers that remains of prehistoric and historic activities may be encountered and, if recognized, should be avoided and promptly reported to BLM cultural resource personnel.

All known cultural resource site locations should be avoided, regardless of the sensitivity zone in which they occur. If a site is to

be impacted in the future, it is recommended that the site be revisited and a controlled surface collection of artifacts be made since this strategy was not included in our field techniques. It may also be prudent to briefly test any endangered site to ensure that no subsurface deposits are present.

With the development of a model based on discriminant functions, site and nonsite locations can be classified with upwards of 80% accuracy, according to our sample. However, more data is needed before the function of the discriminant equation is strong enough to use for management purposes. We recommend that BLM continue to develop the equation. Usefulness of a locale-specific site predictor cannot be overstated. As described in Chapter 5, information about non-site locales from the many square miles of intensively surveyed study tract lands could be easily incorporated into the data base. The equation could also be used in conjunction with survey data from small projects, as a test of its strength and to add to the body of non-site information.

A final comment concerns the sampling design chosen for this inventory. As delineated in the proposal, disadvantages of the preselected random sample are 1) the necessity of developing a research design apart from the sampling design, then trying to integrate the field implementation and results of the two separate designs, or 2) the necessity of trying to fit the research design to the previously devised sampling plan. Advantages center more around BLM's choice of a random over a stratified sample than on the fact that the design was preselected by BLM. Designs based on stratified samples employed on past surveys in this area have met with varying degrees of success. A considerable amount of error in boundary definitions of environmental strata and in the overlap of more than one stratum in single sample units speaks against use of this sampling scheme (Larralde and Nickens 1980). A random sample allows for the construction of relationships between environmental variables and site locations from field observations.

A review of the workings of the sampling design in conjunction with the research design yields two observations. The first concerns the subsistence model set forth in the proposal. The model, based on data from previous surveys adjacent to Seep Ridge, suggested a patterning of site locations based on riverine faunal exploitation (Berry and Berry 1976) and sand dune floral exploitation (Chandler and Nickens 1979b; Larralde and Nickens 1980). Field implementation of the survey resulted in <u>no</u> sites recorded at the river and very few sites recorded in the dune field near Coyote Wash, where a relatively high site density had been expected. Instead, sites clustered near a ridge system that apparently offered floral <u>and</u> faunal resources, as well as other qualities important in specific location decisions. Here, we have a strongly substantiated research design that does not fit field results of a preselected sampling design.

The second observation deals with why sites were not recorded in expected frequencies in riverine and sand dune locales. Although a

number of difficult-to-perceive variables may be responsible for the lack of sites, there is also a possibility that a 10% random sample was not a large enough fraction to ensure that the riverine environment was adequately sampled. Site location on sand dunes seems to depend on a number of variables aside from presence of dunes. Locations possessing these qualities may have also been underrepresented in the sample.

In summary, we applaud BLM's use of a random sample rather than a stratified sample for the Seep Ridge cultural inventory. However, we reiterate our belief that the goals of the BLM and of cultural resource studies would best be served if contractors are allowed to derive their own sampling schemes. It is certainly appropriate for the Bureau to indicate the type of sample needed and the level of inventory. If the contractor is then allowed to select the sampling scheme and the sample units, it is much easier to identify the need for modification at critical times during the fieldwork phase and revise the plan or select new units if necessary. In this type of situation, the BLM should review and comment on the contractor's proposed sampling design and sample unit selection prior to initiation of the field inventory.

REFERENCES CITED

Aikens, C. Melvin
1970 Hogup Cave. University of Utah Anthropological Papers No. 93. Salt Lake City.

Allan, John S.
1979 Vegetation Terrestrial Ecology Studies at the Moon Lake Power Plant Site near Bonanza, Utah. Report prepared for Burns & McDonnell, Kansas City, Missouri.

1980 Moon Lake Project Vegetation Community Analysis along the Transmission System Corridors. Report prepared for Burns & McDonnell, Kansas City, Missouri.

Ambler, J. Richard
1966 Caldwell Village and Fremont Prehistory. University of Utah Anthropological Papers No. 84. Salt Lake City.

Anderson, Jane L., and Ruth A. Henss
1978 Final Report on the Cultural Resource Survey of Core Holes and Access Roads in Three Lease Areas in the Moon Lake Project Area. Unpublished manuscript submitted to Bureau of Land Management, Craig District.

Bender, Henry E., Jr.
1971 Uintah Railway, the Gilsonite Route. Howell-North Books, Berkeley, California.

Berry, Joseph W.
1968 Climates of the States - Colorado. U.S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service. Climatography of the United States No. 60-5.

Berry, Michael S.
n.d. A Sketch of Western Uinta Basin Prehistory. In Tri-State Oil Shale Region Cultural Resource Inventory Plan, edited by J. Hester. Unpublished manuscript.

1974 The Evans Mound: Cultural Adaptation in Southwestern Utah. Unpublished M.A. thesis on file at the Department of Anthropology, University of Utah, Salt Lake City.

Berry, Michael S., and Claudia F. Berry
1976 An Archaeological Reconnaissance of the White River Area, Northeastern Utah. Antiquities Section Selected Papers, No. 4. Salt Lake City.

Binford, Lewis
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45(1):4-20.

Black, Kevin D.
1980 The Prehistoric Context of the Upper Gunnison Basin. In Baseline Cultural Resource Surveys and Evaluations of the Mount Emmons Project: 1978 and 1979 Field Seasons, edited by Steven G. Baker, pp. 51-75. Unpublished report submitted to Bureau of Land Management, Montrose District, Colorado.

Black, Kevin D., Steven M. Horvath, and Steven G. Baker
1980 Survey Findings in Potential Primary Impact Areas. In Baseline Cultural Resource Surveys and Evaluations of the Mount Emmons Project: 1978 and 1979 Field Seasons, edited by Steven G. Baker, pp. 77-136. Unpublished report submitted to Bureau of Land Management, Montrose District, Colorado.

Breternitz, David A.
1965 Archaeological Survey in Dinosaur National Monument, Colorado-Utah, 1963-64. Ms. on file, Bureau of Land Management, Vernal District, Utah.

1970 Archaeological Excavations in Dinosaur National Monument, Colorado-Utah, 1964-1965. University of Colorado Studies, Series in Anthropology, No. 17. University of Colorado, Boulder.

Brown, Kenneth L.
1979 Late Prehistoric Settlement Patterns in Southwestern Kansas. Plains Anthropologist 24(85):191-206.

Brown, Merle
1960 Climates of the States - Utah. Climatography of the United States No. 60-42. U.S. Department of Commerce, Weather Bureau.

Burgh, Robert F.
1950 A Fremont Basketmaker House in Dinosaur National Monument. Tree-Ring Bulletin 16(3):19-20. Tucson.

Burgh, Robert F., and Charles R. Scoggin
1948 The Archaeology of Castle Park, Dinosaur National Monument. University of Colorado Studies, Series in Anthropology, No. 2. Boulder.

Butzer, Karl W.
1971 Environment and Archaeology. Aldine Publishing Co., Chicago.

Bye, Robert A., Jr.
1972 Ethnobotany of the Southern Paiute Indians in the 1870's: with a note on the early ethnobotanical contributions of Dr. Edward Palmer. In Great Basin Cultural Ecology: A Symposium, edited by Don D. Fowler. Desert Research Institute Publications in the Social Sciences, No. 8:87-104. Reno and Las Vegas.

Carpenter, Thorne M., and Morris Steggarda
1939 The Food of the Present-Day Navajo Indians of New Mexico and Arizona. Journal of Nutrition 18:297-305.

Chandler, Susan M., and Paul R. Nickens
1979a Archaeological Investigations of the Coal Development Areas and Coal Transport Corridors for the Moon Lake Project, Rio Blanco County, Colorado, and Uintah County, Utah. Ms. on file at Bureau of Land Management, Vernal District, Utah.

1979b Archaeological Investigations at Two Power Plant Sites and Water Pipeline Corridors for the Moon Lake Project, Rio Blanco County, Colorado, and Uintah County, Utah. Ms. on file at Bureau of Land Management, Vernal District, Utah.

Chandler, Susan M., and John A. Ware
1977 The Discrimination of Technological Behavior: An Experiment in Lithic Replication. Paper presented at the 42nd Annual Meeting of the Society for American Archaeology, New Orleans.

Chase, James E., and Calvin H. Jennings
1978 Archaeological Site Location: A Predictive Methodology. Paper presented at the Plains Anthropological Conference, Denver.

Clark, John
1957 Geomorphology of the Uinta Basin. Intermountain Association of Petroleum Geologists, 8th Annual Field Conference: 17-20.

Coulam, Nancy J., and Peggy R. Barnett
1980 Paleoethnobotanical Analysis. In Sudden Shelter, by Jesse D. Jennings, Alan R. Schroedl, and Richard N. Holmer. University of Utah Anthropological Papers No. 103. Salt Lake City.

Datsrup, B. C.
1963 Vegetational Changes of the Uinta Basin Since Settlement. Unpublished M.A. thesis, Department of Botany, Brigham Young University, Provo.

Day, Kent C.
1964 Thorne Cave, NE Utah: Archaeology. American Antiquity 30(1):50-59.

Dixon, W. J. (editor)
1975 BMD: Biomedical Computer Programs. University of California Press, Berkeley.

Euler, Robert C., and Susan M. Chandler
1978 Aspects of Prehistoric Settlement Patterns in Grand Canyon. In Investigations of the Southwestern Anthropological Research Group, edited by R. Euler and G. Gumerman, pp. 73-85. Museum of Northern Arizona, Flagstaff.

Euler, Robert C., and George J. Gumerman (editors)
1978 Investigations of the Southwestern Anthropological Research Group. The Proceedings of the 1976 Conference. Museum of Northern Arizona, Flagstaff.

Frison, George C.
1970 The Kobold Site, 24BH406: A Post-Altithermal Record of Buffalo Jumping for the Northwestern Plains. Plains Anthropologist 15(47):1-35.

1973 The Wardell Buffalo Trap, 48SU301: Communal Procurement in the Upper Green River Basin, Wyoming. Anthropological Papers of the Museum of Anthropology, University of Michigan, No. 48. Ann Arbor.

1974 The Casper Site, a Hell Gap Bison Kill on the High Plains. Academic Press, New York.

1978 Prehistoric Hunters of the High Plains. Academic Press, New York.

Gillio, David, Frances Levine, and Douglas Scott (compilers)
1980 Some Common Artifacts Found at Historical Sites. Cultural Resource Report No. 31, USDA Forest Service, Southwestern Region.

Gooding, John D.
1979 Cerro Summit, An Archaeological Survey of Squaw Creek. Highway Salvage Report #33. Colorado Department of Highways, Denver.

Grady, James
1980 Environmental Factors in Archaeological Site Location, Piceance Basin, Colorado. Cultural Resource Series No. 9, Bureau of Land Management, Colorado.

Gumerman, George J.
1971 The Distribution of Prehistoric Population Aggregates. Prescott College Anthropological Reports No. 1, Prescott, Arizona.

Gunnerson, James H.
1969 The Fremont Culture: A Study in Cultural Dynamics on the Northern Anasazi Frontier. Papers of the Peabody Museum of Archaeology and Ethnology 59(2). Harvard University, Cambridge, Massachusetts.

Hauck, F. R., D. G. Weder, and S. Kennette
1979 Final Report on the Natural Buttes Cultural Mitigation Study. Unpublished manuscript submitted to the Bureau of Land Management, Vernal District, Utah.

Heizer, Robert F., and Thomas Hester
1978 Great Basin Projectile Points: Forms and Chronology. Ballena Press, Socorro, New Mexico.

Hoel, Paul G.
1971 Elementary Statistics. John Wiley and Sons, New York.

Holmer, Richard N.
1978 A Mathematical Typology for Archaic Projectile Points of the Eastern Great Basin. Unpublished Ph.D. dissertation. Department of Anthropology, University of Utah, Salt Lake City.

1979 Split Mountain Cultural Study Tract, Contract No. UT-080-CT9-003. Unpublished manuscript submitted to the Bureau of Land Management, Vernal District, Utah.

Honea, Kenneth
1965 Early Man Projectile Points in the Southwest. Museum of New Mexico Press, Popular Series Pamphlet No. 4.

1969 The Rio Grande Complex and the Northern Plains. Plains Anthropologist 14:57-70.

Hoover, Robert L.
1966 Antelope Food Habits and Range Relationships in Colorado. In Proceedings of the Second Annual Antelope States Workshop: 75-85. Colorado Game, Fish and Parks Department, Ft. Collins, Colorado.

Jennings, Jesse D., Alan R. Schroedl, and Richard N. Holmer
1980 Sudden Shelter. University of Utah Anthropological Papers No. 103. Salt Lake City.

Jochim, Michael A.
1976 Hunter-Gatherer Subsistence and Settlement: A Predictive Model. Academic Press, New York.

Judge, W. James
1973 Paleo-indian Occupation of the Central Rio Grande Valley in New Mexico. University of New Mexico Press, Albuquerque.

Klecka, William R.
1975 Discriminant Analysis. In Statistical Package for the Social Sciences, by Nie et al., pp. 434-467. McGraw-Hill, New York.

Kvamme, Kenneth
1980 Predictive Model of Site Location in the Glenwood Springs Resource Area. In Class II Cultural Resource Inventory of the Glenwood Springs Resource Area, Grand Junction District, Colorado, by Nickens and Associates. Unpublished manuscript submitted to the Bureau of Land Management, Grand Junction District.

Larralde, Signa L., and Paul R. Nickens
1980 Archaeological Inventory in the Red Wash Cultural Study Tract, Uintah County, Utah. In Sample Inventories of Oil and Gas Fields in Eastern Utah 1978-1979, assembled by Paul R. Nickens. Cultural Resource Series No. 5, Bureau of Land Management, Utah.

Leach, Larry L.
1966 The Archaeology of Boundary Village. Miscellaneous Paper No. 13 in University of Utah Anthropological Papers No. 83: 85-129.

1970 Archaeological Investigations at Deluge Shelter (42UN1). Unpublished Ph.D. dissertation. Department of Anthropology, University of Colorado, Boulder.

Madsen, David B.
1976 Bulldozer Dune (42SL46). Antiquities Section Selected Papers, No. 6. Salt Lake City.

1979 The Fremont and the Sevier: Defining Prehistoric Agriculturalists North of the Anasazi. American Antiquity 44(4):711-722.

1980 Fremont/Sevier Subsistence. In Fremont Perspectives, edited by David B. Madsen. Antiquities Section Selected Papers, No. 16: 25-33. Salt Lake City.

Madsen, David B., and Donald B. Currey
1979 Late Quaternary Glacial and Vegetation Changes, Little Cottonwood Area, Wasatch Mountains, Utah. Quaternary Research 12.

Madsen, Rex E.
1977 Prehistoric Ceramics of the Fremont. Museum of Northern Arizona Ceramic Series, No. 6. Flagstaff.

Marsell, Ray E.
1964 Geomorphology of the Uinta Basin--A Brief Sketch. Intermountain Association of Petroleum Geologists, 13th Annual Field Conference: 29-39.

Marwitt, John P.
1970 Median Village and Fremont Culture Regional Variation. University of Utah Anthropological Papers No. 95. Salt Lake City.

Nie, Norman H., C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Bent
1975 Statistical Package for the Social Sciences. McGraw-Hill, New York.

Nielson, Asa
1978 Proposed Subsistence Model for the Sevier Culture: Sevier River Drainage, West Central Utah. Unpublished M.A. thesis, Brigham Young University, Provo.

O'Connell, James F.
1975 The Prehistory of Surprise Valley. Ballena Press Anthropological Papers, No. 4. Ramona, California.

Putnam, H. E.
1965 Bottle Identification [from the 1910 Illinois Glass Co. catalog]. Old Time Bottle Publishing Co., Salem, Oregon.

Reed, Alan D.
1979 An Archaeological Evaluation of Six Prehistoric Sites in Hale Gulch, in the Pitch Uranium Project Area of Homestake Mining Company, Saguache County, Colorado. Centuries Research, Inc., Montrose, Colorado.

1980a Archaeological Investigations of Two Proposed Water Pipeline Corridors and a Proposed Railroad Right-of-Way for the Moon Lake Project, Northwestern Colorado and Northeastern Utah. Moon Lake Project Report 80-1. Report prepared for Burns & McDonnell, Kansas City, Missouri.

1980b Archaeological Investigations of Proposed Transmission Line Corridors for the Moon Lake Project, Northwestern Colorado, Northeastern Utah, and Southwestern Wyoming. Moon Lake Project Report 80-2. Report prepared for Burns & McDonnell, Kansas City, Missouri.

Reed, Alan D., and Paul R. Nickens
1980 Archaeological Investigations at the DeBeque Rockshelter: A Stratified Archaic Site in West-Central Colorado. Unpublished manuscript on file at the Bureau of Land Management, Grand Junction District, Colorado.

Reher, C. A., and D. C. Witter
1977 Archaic Settlement and Vegetative Diversity. In Settlement and Subsistence Along the Lower Chaco River - The CGP Survey, edited by C. A. Reher, pp. 113-126. University of New Mexico Press, Albuquerque.

Renaud, E. B.
1942 The Rio Grande Points. Southwestern Lore 8(3):33-36.

Severson, Keith E.
1966 An Analysis of Foods and Feeding Habits of Pronghorn Antelope and Domestic Sheep in the Red Desert Basin of Wyoming. In Proceedings of the Second Annual Antelope States Workshop: 22-33. Colorado Game, Fish and Parks Department, Ft. Collins.

Sharrock, Floyd W.
1966 Prehistoric Occupation Patterns in Southwest Wyoming and Cultural Relationships with the Great Basin and Plains Culture Areas. University of Utah Anthropological Papers No. 77, Salt Lake City.

Sharp, Robert P.
1966 Kelso Dunes, Mojave Desert, California. Geological Society of America Bulletin 77(10):1045-1074.

Siegel, Sidney
1956 Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill, New York.

Simms, Steven R.
1979 A Cultural Resource Inventory of the Riverbend Gathering System, Uintah County, Utah. Unpublished manuscript submitted to the Bureau of Land Management, Vernal District, Utah.

Singer, Merrill
1979 The Prehistoric Cultural Ecology of Sand Dunes. In Final Report, Split Mountain Cultural Study Tract, Contract No. UT-080-CT9-003, by Richard N. Holmer. Manuscript on file at the Bureau of Land Management, Vernal District, Utah.

Sisson, Edward B.
1978 Final Report of Survey and Evaluation of Archaeological and Historical Resources: Central Utah Project 1977. Contract No. LX8000-70016 between National Park Service and University of Utah - Salt Lake City.

Smith, Ann M.
1974 Ethnography of the Northern Utes. Papers in Anthropology No. 17, Museum of New Mexico Press.

Smith, H. Duane and Associates
1980a Terrestrial Vertebrate Survey of a Power Plant Site, Alternate Power Plant Site and Their Associated Facilities. Report submitted to Bureau of Land Management, Utah.

1980b Terrestrial Vertebrate Survey of a Transmission System. Report submitted to the Bureau of Land Management, Utah.

Smith, Landon D., and Albert C. Goodyear III
1977 The Statistical Discrimination of Hard and Soft Percussors. Paper presented at the 42nd Annual Meeting of the Society for American Archaeology, New Orleans.

Steggarda, Morris, and Ruth B. Eckardt
1941 Navajo Foods and Their Preparation. Journal of the American Dietetic Association 17:217-225.

Steward, Julian H.
1937 Ancient Caves of the Great Salt Lake Region. Bureau of American Ethnology Bulletin 116, Washington, D.C.

1974 Ute Indians I: Aboriginal and Historical Groups of the Ute Indians of Utah. Native Components of the White River Ute Indians. Garland Publishing, New York.

Stewart, Omer C.
1973 Ethnography of the Western and Eastern Ute. Manuscript on file, Department of Anthropology, University of Colorado, Boulder.

Stokes, William L.
1977 Subdivisions of the Major Physiographic Provinces in Utah. Utah Geology 4(1):1-17.

Toll, Henry Wolcott III
1977 Dolores River Archeology: Canyon Adaptations as Seen Through Survey. Cultural Resources Series No. 4. Bureau of Land Management, Colorado.

Toulouse, Julian H.
1971 Bottle Makers and Their Marks. Thomas Nelson, New York.

Tucker, Gordon C., Jr.
1980 An Archaeological Inventory of the Proposed Paraho Oil Shale Demonstration Module, Phase I, Uintah County, Utah. Report prepared for VTN Consolidated, Irvine, California.

Udy, Jay R.
1953 Effects of Predator Control on Antelope Populations. Utah State Department of Fish and Game, Publication No. 5, Federal Aid Division F.A. 28-R and F.A. 35-D.

Upper Colorado Region State-Federal Inter-Agency Group
1971 Characteristics of Lands: Soils, Appendix 6 in Upper Colorado Region, Comprehensive Framework Study.

U.S. Department of Commerce
1964 Climatic Summary of the United States--Supplement for 1951 through 1960, Colorado. U.S. Government Printing Office, Washington, D.C.

Weber, David A., Kevin T. Jones, Herbert Rodriguez, Calvin H. Jennings, and Daryl J. Daugherty
1977 Archaeological Reconnaissance of Nine In Situ Oil Shale Lease Tracts, Colorado-Utah. Reports of the Laboratory of Public Archaeology, No. 3. Colorado State University, Fort Collins.

Welsh, Stanley L.
1957 An Ecological Survey of the Vegetation of the Dinosaur National Monument, Utah. Unpublished M.A. thesis, Brigham Young University, Provo.

Wheat, Margaret M.
1967 Survival Arts of the Primitive Paiutes. University of Nevada Press, Reno.

Wheeler, Richard P.
1954 Two New Projectile Point Types: Duncan and Hanna Points. Plains Anthropologist No. 1:7-14.

Williams, Leonard, David Hurst Thomas, and Robert Bettinger
1973 Notions to Numbers: Great Basin Settlements as Polythetic Sets. In Research and Theory in Current Archeology, edited by Charles L. Redman, pp. 215-237. John Wiley & Sons, New York.

Wilson, LeMoyne, T. B. Hutchings, and Paul Shafer
1968 Arable Land Resources of Utah. Utah Agricultural Experiment Station, Utah Resource Series 42. Utah State University, Logan.

Winter, Joseph L., and Henry G. Wylie
1974 Paleoecology and Diet at Clyde's Cavern. American Antiquity 39(2), part 1:303-315.

Wormington, H. M.
1957 Ancient Man in North American. Denver Museum of Natural History, Popular Series No. 4.

Several of the Appendices from the original report have been deleted from this publication. Qualified researchers can find these data at either the Bureau of Land Management Vernal District or Utah State Office. Appendices deleted include:

Appendix 1	Sample Unit Form
Appendix 2	Site Summary
Appendix 3	Catalog of Isolated Finds
Appendix 5	Fossils
Appendix 11	Site Forms

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
IF 2	purple glass sherd, appliqued edge	2.6 (frag.)	2.0	.8	glass	Euro-American pre 1915	insulator lip? Fig.
IF 3	purple glass bottle neck	5.3	3.2	2.2 mouth dia.	glass	Euro-American pre 1915	Fig.
IF 9	broken purple bottle (reconstructed)	14.8	4.9	2.7 mouth dia.	glass	Euro-American pre 1915	Fig.
IF 14	projectile point	2.9	1.8	.5	light brown chert	Archaic	stemmed, concave base, Pinto/ Duncan-Hanna Fig.
IF 18.1	projectile point	4.5	2.7	.7	red/brown chert, crystal-line inclusions	Archaic/ Fremont/ Shoshonean	corner-notched, convex base, Elko Series Fig.
IF 18.2	projectile point	1.7	.9	.2	white chert	Fremont/ Shoshonean	Desert Side-Notched Fig.
IF 19	bifacially flaked blade tip	9.1	4.8	1.0	light brown quartzite	unknown	base missing
IF 24	projectile point	3.3	2.3	.4	light brown chert	Archaic	corner-notched, indented base, fragmentary, Pinto Series

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY
(continued)

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
IF 26	projectile point base	1.7	1.8	.4	light brown chert	Archaic/ Fremont/ Shoshonean	corner-notched, straight base, Elko Series Fig.
IF 28	projectile point	5.5	2.6	.9	light brown chert	Paleo-Indian	stemmed, slight shoulder, Hell Gap Fig.
IF 32	purple glass vaseline jar	6.5	4.5 dia.	3.3 mouth dia.	glass	Euro-American pre 1915	Fig.
IF 46	projectile point fragment	3.2	2.2	.3	white chert, brown streaks	unknown	
IF 49	aqua glass vial	8.4	1.7 dia.	1.4 mouth dia.	glass	Euro-American pre 1920	Fig.
IF 50	projectile point (?) fragment	2.0	2.7	.3	white chert	unknown	tip and base missing
IF 54	projectile point fragment	2.2	1.8	.4	orange chert	Archaic/ Fremont/ Shoshonean	corner-notched, concave base, Elko Series Fig.
IF 56.1	bifacially flaked tool	3.6	2.7	.4	gray chert, large inclusions	Archaic	

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY
(continued)

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
IF 56.2	projectile point fragment	2.3	2.1	.5	gray quartzite	Archaic	unnotched, concave base, McKean/ Humboldt Series Fig.
IF 73.1	drill fragment	3.8	1.9	.4	pumpkin chert	Fremont/ Shoshonean	Fig.
IF 73.2	projectile point	1.3	2.5	.2	translucent white chalcedony	Fremont/ Shoshonean	Desert Side-Notched Fig.
IF 74	projectile point (?) fragment	1.7	1.8	.2	dark brown chert	unknown	
IF 88	bifacially flaked blade	12.7	3.5	.9	gray quartzite	unknown	Fig.
IF 101	projectile point fragment	3.7	2.0	.5	pumpkin chert	Archaic/ Fremont/ Shoshonean	tip and base missing, Elko Series? Fig.
42UN917.1	projectile point	2.5	1.7	.4	heat-treated pumpkin chert (red)	Archaic	tip and 1 tang missing, Pinto Series Fig.
42UN917.4	bifacially flaked tool	2.7	1.7	.5	brown chert	unknown	
42UN918.1	projectile point midsection	2.3	1.5	.3	light brown chert	unknown	

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY (continued)

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
42UN918.2	projectile point	4.5	2.8	.5	light brown chert	Archaic/ Fremont/ Shoshonean	convex base, deep corner notches, Elko Series Fig.
42UN919	non-utilized flake	2.7	1.6	.5	obsidian	unknown	
42UN919-G	bifacially flaked blade	9.4	3.9	1.1	brown chert	unknown	base broken Fig.
42UN919-H	projectile point base	2.8	2.0	.5	white/rose chalcedony	Archaic/ Fremont/ Shoshonean	tip missing Fig.
42UN919-I	bifacially flaked tool	2.9	2.3	.3	white chert	unknown	base missing
42UN919-J	projectile point base	1.1	1.2	.2	brown chalcedony	Fremont/ Shoshonean	unnotched, tip missing, Cottonwood Triangular Fig.
42UN919-K	projectile point	3.7	2.3	.5	brown chert	Archaic	stemmed, concave base, Pinto/Duncan-Hanna Series Fig.
42UN921.2	projectile point fragment	1.2	1.7	.3	white chert	unknown	tip and base missing

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY
(continued)

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
42UN921.3	"Columbia catsup" bottle cap	---	2.5 dia.	---	metal	Euro-American pre 1915	Fig.
42UN924.3	projectile point base	1.4	1.5	.1	white chert	Fremont/ Shoshonean	Desert Side-Notched Fig.
42UN931.1	sherds (4)	---	---	.5 - .8	ceramic	Fremont	Emery Gray: 3 rim sherds, 1 jar body sherd, all corru-gated Fig.
42UN935.4	projectile point tip	3.9	1.8	.3	brown chert, white patina	unknown	base missing
42UN939.8	projectile point	4.1	1.9	.3	light brown quartzite	Archaic/ Fremont/ Shoshonean	unnotched, convex base Fig.
42UN941.1	projectile point base	2.6	1.8	.3	oolitic chert	Archaic/ Fremont/ Shoshonean	corner-notched, straight base, Elko Series Fig.
42UN942.1	projectile point	2.3	1.4	.2	tan quartzite	Fremont/ Shoshonean	tip missing, Cottonwood Triangular Fig.

APPENDIX 4

CATALOG OF COLLECTED ARTIFACTS, SEEP RIDGE CULTURAL INVENTORY (continued)

ID No.	Description	Dimensions (cm) Length	Width	Thickness	Material	Affiliation	Remarks
42UN943.1	projectile point fragment	2.0	1.5	.2	black/brown chert	Fremont/ Shoshonean	Desert Side-Notched Fig.
42UN943.2	projectile point fragment	1.9	1.4	.2	light brown chert	unknown	tangs, tip, and base missing
42UN954.3	projectile point midsection	1.4	1.5	.2	obsidian	unknown	
42UN954.6	projectile point tip	1.7	1.3	.2	brown chert	unknown	notch on one corner

APPENDIX 6

VEGETATION COVER AND FREQUENCY DATA, PROPOSED BONANZA POWER PLANT SITE AND ASSOCIATED FACILITIES* IN AND NEAR THE SEEP RIDGE STUDY TRACT

*from Allan 1979 and 1980. A summary of methodology is included below.

Methodology used during the Moon Lake terrestrial ecology study (Allan 1979:12-15).

The following summary of methodology is excerpted from Dr. Allan's report.

It should be noted that saltbush, sand dune association, grasslands, and riparian data are from study plots within the proposed Bonanza Power Plant site. Juniper data is from a stand near the town of Red Wash. Sagebrush data is a summary of five stands, three of which are located in coal transport corridors within Seep Ridge study tract boundaries. The remaining two stands are located between the Colorado-Utah state line and the proposed mine lease area northeast of the town of Rangely. The data included in this Appendix are believed to best represent the plant ecology of the Seep Ridge study tract. No data are available for White River riparian vegetation within the tract. For more detailed information, see Dr. Allan's reports (1979, 1980).

Plant Inventory

The methodology used in the vegetation surveys is based on the Bureau of Land Management Draft 1731 - Soil Vegetation Inventory Method (SVIM) (BLM 1978) which was recently developed for mapping soils and vegetation and for the collection of important botanical characteristics. This procedure provides a uniform and systematic method for making inventories of soil and vegetation resources and for collection of data to be used in unit reports, management papers, and environmental statements.

Cover and frequency sample data were collected on all vascular plant life forms and cover, frequency, density, and height data were collected on tree and shrub life forms at each transect site. Cover data are obtained by a step point method in which 200 points are stepped off and any species that occurs under a 1/8th inch notch on the toe of the sampler's boot is recorded. At the first point a stake is driven to permanently mark the transect and the compass direction is recorded. Most stands are sampled by two 100-point transect lines that are each approximately 600 feet long for a total of 1200 feet length of sample line.

At the first step point and at every tenth point thereafter a one meter square quadrat is set up and all species that occur in it are recorded to obtain frequency data in a total of 20 quadrats. At every other 10th point a 1/100th acre or a 1/200th acre plot is scribed around a central steel stake with a light chain. In these plots the number of each species of shrub or tree is counted to obtain density data. The plot boundaries are determined by a radius of 11.7 feet for the 1/100th acre plot and 8.3 feet for the 1/200th acre plot. Choice of size of plot to use is determined at a preliminary reconaissance of the area according to the apparent thickness and height of the shrubs or trees present.

The data obtained from the transects and plots are used in this study to characterize the various vegetative communities as to species composition, ground cover, and by life form (trees, shrubs, grasses, perennial forbs, annuals, and cryptogams). Enough stands in each community type were sampled to give statistically adequate samples (7 to 12) so that the variation in species frequency, cover, and density composition could be evaluated quantitatively.

Many of the sites chosen and sampled were selected to correspond with faunal studies performed on emblin grids (Smith 1980a, b). These transects were run along number 4 and 6 grid lines so that each of the 20 quadrats and the 10 density count plots occurred at or near the corresponding grid stakes.

Taxonomy

Questionable species were collected when they occurred in the transects or nearby and were either identified in the field for preliminary names or were later identified by personnel of the Brigham Young University Herbarium. Nomenclature follows that of Welsh and Moore (1973) and Holmgren and Reveal (1966) with several changes that are based on more recent revisions such as those listed in Dr. Stanley Welch's report on threatened and endangered plant species.

REFERENCES CITED

Bureau of Land Management
1978 1731 - Soil Vegetation Inventory Methods (Draft Manual).

Holmgren, A. H., and J. L. Reveal
1966 Checklist of the Vascular Plants of the Intermountain Region. U.S. Forest Service Research Paper INT-32. Intermountain Forest and Range Experiment Station. Ogden, Utah.

Welsh, S. L., and G. Moore
1973 Utah Plants, Tracheophyta. Brigham Young University Press, Provo, Utah.

APPENDIX 6
VEGETATION COVER DATA

N = (# stands sampled)	SALTBUSH STANDS 4 Avg. % Cover	Rel. % Cover	SAND DUNE ASSOC. STANDS 4 Avg. % Cover	Rel. % Cover	SAGEBRUSH STANDS 5 Avg. % Cover	Rel. % Cover	GRASSLAND STANDS 2 Avg. % Cover	Rel. % Cover	RIPARIAN STAND 1 % Cover	Rel. % Cover	JUNIPER STAND 1 GR 4 % Cover	Rel. % Cover
Species												
Trees and Shrubs												
Juniperus osteosperma											22.25	45.68
Artemisia spinescens	7.78	11.43			0.40	0.57						
Artemisia tridentata					12.14	17.24			19.00	29.23	4.90	10.00
Atriplex canescens			3.40	6.63			0.75	0.91				
Atriplex confertifolia					2.96	4.21					0.98	2.00
Atriplex cuneata	9.98	14.67			0.59	0.84						
Certoides lanata					0.79	1.13	0.24	0.29				
Chrysothamnus linifolius									2.50	3.85		
Chrysothamnus nauseosus			1.19	2.32								
Chrysothamnus viscidiflorus							15.10	18.51	1.50	2.31		
var. *puberulus*	0.48	0.70	2.22	4.33	1.18	1.67					2.94	6.00
Chrysothamnus greeneii	0.12	0.18	5.45	10.62	0.90	1.28			0.50	0.77		
Grayia spinosa	0.12	0.18	3.17	6.18	1.09	1.55					1.96	4.00
Gutierezia sarothrae					0.30	0.42	0.75	0.91				
Sarcobatus vermiculatus			0.37	0.72	0.80	1.13	0.25	0.31	5.00	7.69	0.98	2.00
Tetradymia spinosa	1.10	1.62			0.39	0.56						
Trees and Shrubs Subtotal	19.58	28.78	15.81	30.79	21.53	30.64	17.07	20.43	28.50	43.85	34.01	69.68
Grasses												
Agropyron cristatum					0.59	0.85						
Agropyron smithii			0.12	0.24	4.57	6.50					0.98	2.00
Agropyron spicatum					1.39	1.98						
Agropyron spicatum var. *inerme*					0.70	1.00						
Distichlis stricta			0.83	1.62								
Hilaria jamesii	0.48	0.70	1.72	3.40	6.03	8.58	18.38	22.54			0.98	2.00
Muhlenbergia pungens			0.62	1.21								
Oryzopsis hymenoides	0.97	1.43	13.70	27.03	1.29	1.84	0.47	0.58	0.50	0.77	1.96	4.00
Poa sandbergii					0.80	1.13						
Sitanion hystrix					0.10	0.14	0.26	0.32				
Sporobolus airoides			0.12	0.24								
Sporobolus cryptandrus	0.36	0.53										
Stipa comata			0.86	1.70	3.19	4.54	10.40	12.75				
Stipa lettermannii			0.12	0.24								
Grass Subtotal	1.80	2.66	18.09	35.68	18.66	26.55	29.25	36.19	0.50	0.77	3.92	8.00

APPENDIX 6
VEGETATION COVER DATA
(continued)

N = (# stands sampled)	SALTBUSH STANDS 4		SAND DUNE ASSOC. STANDS 4		SAGEBRUSH STANDS 5		GRASSLAND STANDS 2		RIPARIAN STAND 1		JUNIPER STAND 1	
Species	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	% Cover	Rel. % Cover	GR 4 % Cover	Rel. % Cover
Forbs												
Agoseris glauca					0.40	0.57						
Allium textile					0.30	0.43						
Asclepias speciosa									0.50	0.77		
Astragalus chamaleuce	0.25	0.34	0.25	0.49			0.71	0.87				
Astragalus convallarius			1.21	2.36	0.30	0.43						
Bahia nudicaulis					0.10	0.14						
Brickelia oblongifolia									1.00	1.54		
Castilleja chromosa					0.10	0.14						
Comandra umbellatum			0.12	0.24								
Cordylanthus kingii									0.50	0.77		
Cymopterus bulbosus	0.13	0.19										
Delphinium menziesii					0.10	0.14						
Erigeron pumila	0.13	0.19			0.10	0.14						
Erysimum asperum	0.60	0.88			0.30	0.42						
Lepidium montanum									1.00	1.54	3.92	8.00
Leptodactylon pungens					0.20	0.28						
Leucelenc ericoides	0.60	0.83			1.10	1.57						
Machaeranthera linearis	0.36	0.53	0.12	0.24	0.20	0.28						
Oenothera trichocalyx	0.13	0.19										
Opuntia polyacantha	0.37	0.54			0.20	0.28	3.11	3.81				
Penstemon fremontii							1.74	2.13				
Phlox longifolia	0.12	0.18			0.60	0.85						
Physaria acutifolia			1.23	2.40								
Sisymbrium linifolium					0.10	0.14						
Sphaeralcea coccinia	1.36	2.0			3.97	5.65	0.95	1.16				
Sphaeralcea parvirolia			0.25	0.49								
Stephanomeria exigua			0.37	0.72								
Streptanthus cordatus			0.49	0.95					1.50	2.31		
Trifolium gymnocarpon					0.10	0.14						
Perennial Forb Subtotal	4.05	5.92	4.05	7.89	8.16	11.61	6.50	7.96	4.50	6.92	3.92	8.00
Annuals												
Ambrosia acanthicarpa			0.25	0.49								
Atriplex elegans					2.08	2.96						
Bromus tectorum	12.40	18.22	1.47	2.86	16.96	24.13	15.33	18.80	13.50	20.77	2.94	6.00
Chaenactis stevioides			0.12	0.24			0.71	0.87				
Chenopodium fremontii											0.98	2.00
Cryptantha crassisepala							0.73	0.90			0.98	2.00
Descurainia richardsonii					0.14				0.50	0.77		
Draba repens									1.00	1.54		
Ranunculus testiculatus					0.60	0.85						

APPENDIX 6
VEGETATION COVER DATA
(continued)

N = (# stands sampled)	SALTBUSH STANDS 4		SAND DUNE ASSOC. STANDS 4		SAGEBRUSH STANDS 5		GRASSLAND STANDS 2		RIPARIAN STAND 1		JUNIPER STAND 1	
Species	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	Avg. % Cover	Rel. % Cover	% Cover	Rel. % Cover	GR 4 % Cover	Rel. % Cover
Annuals Continued												
Echinopsilon hyssiopfolium					0.14							
Festuca octoflora	0.50	0.73					0.97	1.18				
Gilia leptomeria	0.13	0.19	2.19	4.27	0.20	0.28	0.49	0.59	1.50	2.31	0.98	2.00
Gilia polyacantha	0.25	0.37										
Gilia pumila	0.85	1.25			0.20	0.28	2.36	2.89				
Halogeton glomeratus	3.36	4.94			0.20	0.28						
Lappula occidentalis	0.37	0.54			0.10	0.14	0.47	0.58	1.00	1.54		
Lepidium densiflorum	0.50	0.73			0.60	0.85	0.47	0.58	1.50	2.31		
Lupinus pusillis			0.12	0.24								
Malacothrix sonchoides			0.25	0.49								
Malcolmia africana	15.32	22.51							11.00	16.92		
Mentzelia albicaulis			3.64	7.09	0.10	0.14	3.20	3.92				
Nama densum			0.49	0.95								
Phacelia ivesiana			0.60	1.17								
Plantago purshii	5.74	8.43					3.07	3.76				
Salsola kali	0.74	1.09	4.00	7.79			0.96	1.18	0.50	0.77	0.98	2.00
Tiquilia nuttallii			0.12	0.24								
Annuals Subtotal	40.16	59.00	13.25	25.83	21.32	30.21	28.74	35.24	31.00	47.69	6.86	14.83
Cryptogams												
Lichens	2.09	3.07			0.50	0.71			0.50	0.77		
Moss	0.37	0.54	0.12	0.24	0.20	0.28						
Cryptogam Subtotal	2.46	3.61	0.12	0.24	0.70	0.99	00.00	00.00	0.50	0.77	00.00	00.00
TOTAL LIVING COVER*	68.05	100.00	51.32	100.00	70.37	100.00	81.56	100.00	65.00	100.00	48.71	100.00

*varies from 100% - Nonliving cover due to multiple hits occurring with use of point method (Allan 1980:41).

APPENDIX 6
VEGETATION FREQUENCY DATA

N = (# stands sampled)	SALTBUSH STANDS 4 Avg. % F.	SALTBUSH STANDS 4 Rel. % F.	SAND DUNE ASSOC. STANDS 4 Avg. % F.	SAND DUNE ASSOC. STANDS 4 Rel. % F.	SAGEBRUSH STANDS 5 Avg. % F.	SAGEBRUSH STANDS 5 Rel. % F.	GRASSLAND STANDS 2 Avg. % F.	GRASSLAND STANDS 2 Rel. % F.	RIPARIAN STAND 1 % F.	RIPARIAN STAND 1 Rel. % F.	JUNIPER STAND 1 Avg. % F.	JUNIPER STAND 1 Rel. % F.
Species												
Trees and Shrubs												
Juniperus osteosperma											5.00	2.56
Artemisia spinescens	52.50	6.13			3.00	0.48						
Artemisia tridentata					58.00	9.28			50.00	11.36	15.00	7.69
Atriplex canescens			11.25	1.80			7.50	0.90				
Atriplex confertifolia			2.50	0.40	24.00	3.84	7.50	0.90	10.00	2.27		
Atriplex cuneata	62.50	7.30			5.00	0.80						
Certoides lanata					8.00	1.28			10.00	2.27		
Chrysothamnus nauseosus			7.50	1.20								
Chrysothamnus viscidiflorus			8.75	1.40	7.00	1.12					15.00	7.69
var. *puberulus*			22.50	3.61								
Chrysothamnus greeneii					5.00	0.80						
Grayia spinosa	1.25	0.15	6.25	1.00	5.00	0.80						
Gutierezia sarothrae					5.00	0.80						
Sarcobatus vermiculatus			2.50	0.40	4.00	0.64			10.00	2.27		
Tamarix pentandra									5.00	1.14		
Tetradymia spinosa	3.75	0.44			1.00	0.16						
Trees and Shrubs Subtotal	120.00	14.01	61.25	9.82	125.00	20.00	15.00	1.81	85.00	18.32	35.00	17.94
Grasses												
Agropyron cristatum					9.00	1.44					15.00	7.69
Agropyron smithii	1.25	0.15	1.25	0.20	28.00	4.48						
Agropyron spicatum					20.00	3.20						
Disichlis stricta			6.25	1.00								
Hilaria jamesii	1.25	0.15	6.25	1.00	23.00	3.68	85.00	10.24			10.00	5.13
Muhlenbergia pungens			3.75	0.60								
Oryzopsis hymenoides	22.50	2.63	71.25	11.42	11.00	1.76	20.00	2.41			15.00	7.69
Poa sandbergii	1.25	0.15			14.00	2.24						
Sitanion hystrix	1.25	0.15			8.00		2.50	0.30	5.00	1.14		
Sporobolus cryptandrus	3.75	0.44										
Stipa comata			5.00	0.80	10.00	1.60	35.00	4.22				
Stipa lettermannii			3.75	0.60								
Grass Subtotal	31.25	3.65	97.50	15.63	123.00	19.68	142.50	17.17	5.00	1.14	40.00	20.51
Forbs												
Agoseris glauca					2.00	0.32						
Allium textile	1.25	0.15			8.00	1.28	7.50	0.90				
Androstephium breviflorum							20.00	2.41				
Arabis pulchra			5.00	0.80								
Arenaria eastwoodiae					1.00	0.16						
Astragalus chamaleuce	23.75	2.77	25.00	4.01	2.00	0.32	50.00	6.02	5.00	1.14		
Astragalus cibarius			6.25	1.00								
Astragalus convallarius			12.50	2.00	8.00	1.28						
Bahia nudicaulis					1.00	0.16						
Calochortus nuttallii					6.00	0.96						

APPENDIX 6
VEGETATION FREQUENCY DATA
(continued)

N = (# stands sampled)	SALTBUSH STANDS 4		SAND DUNE ASSOC. STANDS 4		SAGEBRUSH STANDS 5		GRASSLAND STANDS 2		RIPARIAN STAND 1		JUNIPER STAND 1	
Species	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	% F.	Rel. % F.	Avg. % F.	Rel. % F.
Forbs Continued												
Camelina microcarpa			1.25	0.20	7.00	1.12						
Comandra umbellatum			1.25	0.20	1.00	0.16						
Cymopterus bulbosus	1.25	0.15			8.00	1.28						
Erigeron engelmannii	5.00	0.58										
Erigeron pumila	27.50	3.21			12.00	1.92	2.50	0.30	5.00	1.14		
Eriogorum jamesii					1.00	0.16						
Euphorbia fendleri					2.00	0.32						
Happlopappus nuttallii					1.00	0.16						
Helianthus petiolaris									10.00	2.27		
Lepidium montanum					1.00	0.16					5.00	2.56
Leptodactylon pungens					9.00	1.44						
Leucelene ericoides					4.00	0.65						
Machaeranthera linearis	1.25	0.15	8.75	1.40	5.00	0.80					5.00	2.56
Oenothera trichocalyx	8.75	1.02										
Opuntia polyacantha	3.75	0.44	3.75	0.60	4.00	0.64	17.50	2.11				
Pediocactus simpsonii					1.00	0.16						
Phlox longifolia					9.00	1.44						
Physaria acutifolia			11.25	1.80	2.00	0.32			10.00	2.27		
Sisymbrium altissimum					1.00	0.16						
Sisymbrium linifolium					10.00	1.60						
Sphaeralcea coccinia	27.50	3.21			45.00	7.20	22.50	2.71	5.00	1.14		
Sphaeralcea parvirolia	1.25	0.15										
Stephanomeria exigua			11.25	1.80	1.00	0.16	2.50	0.30				
Trifolium gymnocarpon					8.00	1.28						
Wyethia scabra			1.25	0.20								
Forb Subtotal	101.25	11.82	81.25	13.03	160.00	25.60	122.50	14.76	45.00	10.23	10.00	5.13
Annuals												
Ambrosia acanthicarpa			7.50	1.20								
Bromus tectorum	91.25	10.66	22.50	3.61	84.00	13.44	60.00	7.23	85.00	19.32	5.00	2.56
Camasonia contorta			5.00	0.80	4.00	0.64						
Camasonia pterosperma			13.75	2.20								
Chaenactis stevioides	1.25	0.15	2.50	0.40			15.00	1.81	5.00	1.14		
Chenopodium fremontii									5 00	1.14	5.00	2.56
Chenopodium leptophyllum			7.50	1.20	5.00	0.80	7.50	0.90				
Cleome lutea	48.75	5.69	1.25	0.20			2.50	0.30	5.00	1.14		
Cryptantha crassisepala	2.50	0.29	23.75	3.81	1.00	0.16	60.00	7.23	5.00	1.14	10.00	5.13
Descurainia richardsonii					8.00	1.28			15.00	3.41		
Echinopsilon hyssiopfolium									10.00	2.27		
Erigonum cernuum			6.25	1.00								
Erigonum gordonii			7.50	1.20	2.00	0.32	7.50	0.90	5.00	1.14	25.00	12.82
Festuca octoflora	10.00	1.17	6.25	1.00	2.00	0.32	50.00	6.02	10.00	2.27	5.00	2.56
Gilia congesta			1.25	0.20					5.00	1.14		

APPENDIX 6
VEGETATION FREQUENCY DATA
(continued)

N = (# stands sampled)	SALTBUSH STANDS 4		SAND DUNE ASSOC. STANDS 4		SAGEBRUSH STANDS 5		GRASSLAND STANDS 2		RIPARIAN STAND 1		JUNIPER STAND 1	
Species	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	Avg. % F.	Rel. % F.	% F.	Rel. % F.	Avg. % F.	Rel. % F.
Annuals Continued												
Gilia leptomeria	1.25	0.15	61.25	9.82	5.00	0.80	50.00	6.02	20.00	4.55	25.00	12.82
Gilia polyacantha	6.25	0.73										
Gilia pumila	61.25	7.15	7.50	1.20	5.00	0.80	55.00	6.63	10.00	2.27		
Halogeton glomeratus	40.00	4.67	2.50	0.40					10.00	2.27		
Helianthus annua	7.50	0.88	1.25	0.20								
Lappula occidentalis	13.75	1.61			22.00	3.52	17.50	2.11	5.00	1.14		
Lepidium densiflorum	22.25	2.62			14.00	2.24	37.50	4.52	35.00	7.95		
Lepidium perfoliatum	12.50	1.46										
Lupinus brevicaulis					1.00	0.16						
Lupinus pusillis	3.75	0.44	10.00	1.60								
Malacothrix sonchoides	1.25	0.15	10.00	1.60			15.00	1.81				
Malcolmia africana	70.00	8.18							50.00	11.36		
Mentzelia albicaulis	1.25	0.15	62.50	10.02	4.00	0.64	57.50	6.93			10.00	5.13
Nama densum			38.75	6.21			2.50	0.30				
Phacelia ivesiana	2.50	0.29	16.25	2.61	1.00	0.16	20.00	2.41			10.00	5.13
Plantago purshii	92.50	10.80			16.00	2.56	40.00	4.82				
Salsola kali	23.75	2.77	62.50	10.02	10.00	1.60	50.00	6.02	20.00	4.55	15.00	7.69
Annuals Subtotal	513.75	60.00	377.50	60.52	185.00	28.60	547.50	65.96	300.00	68.18	110.00	56.41
Cryptogams												
Lichens	68.75	8.03	1.25	0.20	19.00	3.04			5.00	1.14		
Moss	21.25	2.48	5.00	0.80	3.00	2.08	2.50	0.30				
Cryptogams Subtotal	90.00	10.51	6.25	1.00	32.00	5.12	2.50	0.30	5.00	1.14	00.00	00.00
Grand Totals	856.25	100.00	623.75	100.00	625.00	100.00	830.00	100.00	440.00	100.00		
Total No. Vascular Species	Avg.	20.5	Avg.	27	Avg.	26.2	Avg.	22.5		30		17

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT
(Smith 1980a: Tables 1, 2 and 3)

Species	P/L/O*
Common Loon	L
Horned Grebe	L
Eared Grebe	L
Western Grebe	L
Pied-billed Grebe	O
White Pelican	L
Double-crested Cormorant	L
Great Blue Heron	O
Green Heron	L
Little Blue Heron	L
Snowy Egret	L
Black-crowned Night Heron	L
American Bittern	O
White-faced Ibis	L
Whistling Swan	L
Canada Goose	O
White-fronted Goose	L
Snow Goose	P
Mallard	O
Gadwall	O
Pintail	O
Green-winged Teal	O
Blue-winged Teal	O
Cinnamon Teal	O
American Wigeon	L
Northern Shoveler	O
Wood Duck	L
Redhead	L
Ring-necked Duck	L
Canvasback	L
Lesser Scaup	L
Common Goldeneye	L
Barrow's Goldeneye	L
Bufflehead	L
Oldsquaw	L
White-winged Scoter	L
Ruddy Duck	L
Hooded Merganser	L
Common Merganser	L
Red-breasted Merganser	L
Turkey Vulture	O
Sharp-shinned Hawk	L
Cooper's Hawk	L
Red-tailed Hawk	O
Swainson's Hawk	L
Rough-legged Hawk	L
Ferruginous Hawk	O

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT
(continued)

Species	P/L/O*	Species	P/L/O*
Golden Eagle	O	Black-bellied Plover	L
Bald Eagle	L	Ruddy Turnstone	L
Harrier	O	Common Snipe	L
Osprey	L	Long-billed Curlew	L
Prairie Falcon	O	Whimbrel	P
Peregrine Falcon	L	Spotted Sandpiper	O
Merlin	L	Solitairy Sandpiper	O
American Kestrel	O	Willet	O
Sage Grouse	O	Greater Yellowlegs	L
Gambel's Quail	P	Lesser Yellowlegs	O
Ring-necked Pheasant	O	Pectoral Sandpiper	P
Chukar	L	Baird's Sandpiper	L
Sandhill Crane	L	Least Sandpiper	O
Virginia Rail	L	Dunlin	P
Sora	L	Long-billed Dowitcher	O
American Coot	O	Semipalmated Sandpiper	P
Semipalmated Plover	L	Western Sandpiper	L
Snowy Plover	L	Marbled Godwit	O
Killdeer	O	Sanderling	L
Mountain Plover	O	American Avocet	O

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT (continued)

Species	P/L/O*	Species	P/L/O*
Black-necked Stilt	O	Pygmy Owl	L
Wilson's Phalarope	O	Burrowing Owl	O
Northern Phalarope	L	Spotted Owl	P
Herring Gull	P	Long-eared Owl	L
California Gull	L	Short-eared Owl	O
Ring-billed Gull	L	Poor-Will	L
Franklin's Gull	L	Common Nighthawk	O
Bonaparte's Gull	L	White-throated Swift	O
Forster's Tern	L	Black-chinned Hummingbird	L
Common Tern	L	Broad-tailed Hummingbird	O
Black Tern	L	Rufous Hummingbird	O
Band-tailed Pigeon	P	Calliope Hummingbird	P
Rock Dove	L	Belted Kingfisher	O
White-winged Dove	L	Common Flicker	O
Mourning Dove	O	Red-headed Woodpecker	L
Yellow-billed Cuckoo	L	Lewis' Woodpecker	L
Barn Owl	P	Yellow-bellied Sapsucker	L
Screech Owl	L	Williamson's Sapsucker	L
Great Horned Owl	O	Hairy Woodpecker	L
Snowy Owl	P	Downy Woodpecker	O

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT (continued)

Species	P/L/O*	Species	P/L/O*
Eastern Kingbird	O	Stellar's Jay	L
Cassin's Kingbird	O	Scrub Jay	L
Scissor-tailed Flycatcher	L	Black-billed Magpie	O
Ash-throated Flycatcher	L	Common Raven	O
Eastern Phoebe	O	Common Crow	L
Say's Phoebe	O	Pinyon Jay	O
Traill's Flycatcher	L	Clark's Nutcracker	
Hammond's Flycatcher	L	Black-capped Chickadee	
Dusky Flycatcher	L	Mountain Chickadee	
Gray Flycatcher	O	Plain Titmouse	L
Western Flycatcher	L	Common Bushtit	P
Western Wood Peewee	L	White-breasted Nuthatch	L
Olive-sided Flycatcher	O	Red-breasted Nuthatch	L
Horned Lark	O	Dipper	
Violet-green Swallow	O	House Wren	O
Tree Swallow	O	Bewick's Wren	O
Bank Swallow	L	Long-billed Marsh Wren	L
Rough-winged Swallow	O	Canyon Wren	L
Barn Swallow	O	Rock Wren	O
Cliff Swallow	O	Mockingbird	L

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT
(continued)

Species	P/L/O*	Species	P/L/O*
Gray Catbird	P	Virginia's Warbler	L
Brown Thrasher	L	Yellow Warbler	O
Sage Thrasher	O	Yellow-rumped Warbler	O
American Robin	O	Black-throated Gray Warbler	L
Varied Thrush	L	MacGillivray's Warbler	O
Hermit Thrush	L	Common Yellowthroat	O
Western Bluebird	L	Yellow-breasted Chat	L
Mountain Bluebird	O	Wilson's Warbler	O
Townsend's Solitaire	O	American Redstart	L
Blue-gray Gnatcatcher	O	House Sparrow	L
Ruby-crowned Kinglet	L	Bobolink	O
Bohemian Waxwing	L	Western Meadowlark	O
Cedar Waxwing	L	Yellow-headed Blackbird	O
Northern Shrike	L	Red-winged Blackbird	O
Loggerhead Shrike	O	Scott's Oriole	O
Starling	1	Northern Oriole	O
Gray Vireo	L	Brewer's Blackbird	O
Solitary Vireo	L	Brown-headed Cowbird	L
Orange-crowned Warbler	L	Western Tanager	O
Nashville Warbler	P	Black-headed Grosbeak	L

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT
(continued)

Species	P/L/O*	Species	P/L/O*
Blue Grosbeak	O	Dark-eyed Junco	L
Lazuli Bunting	O	Gray-headed Junco	L
Evening Grosbeak	L	Tree Sparrow	L
Cassin's Finch	L	Chipping Sparrow	O
House Finch	O	Brewer's Sparrow	O
Gray-crowned Rosy Finch		Harris' Sparrow	L
Black Rosy Finch		White-crowned Sparrow	O
Brown-capped Rosy Finch		White-throated Sparrow	L
Common Redpoll		Fox Sparrow	P
Pine Siskin		Lincoln's Sparrow	L
American Goldfinch	O	Song Sparrow	O
Lesser Goldfinch	P	McCown's Longspur	P
Green-tailed Towhee	L	Snow Bunting	P
Rufous-sided Towhee	O		
Lark Bunting	O		
Savannah Sparrow	L		
Grasshopper Sparrow	P		
Vesper Sparrow	L		
Lark Sparrow	O		
Black-throated Sparrow	L		
Sage Sparrow	O		

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT (continued)

Species	P/L/O*	Species	P/L/O*
Merriam's Shrew Sorex merriami	P	Hoary Bat Lasiurus cinereus	L
Vagrant Shrew Sorex vagrans	P	Spotted Bat Euderma maculata	P
Dwarf Shrew Sorex nanus	P	Western Big-eared Bat Plecotus townsendi	L
Little Brown Myotis Myotis lucifugus	P	Pallid Bat Antrozous pallidus	L
Cave Myotis Myotis velifer	P	Big Free-tailed Bat Tadarida molossa	P
Fringed Myotis Myotis thysanodes	P	Mexican Free-tailed Bat Tadarida brasiliensis	P
Long-earned Myotis Myotis evotis	L	Racoon Procyon lotor	O
California Myotis Myotis californicus	P	Ringtail Bassariscus astutus	L
Yuma Myotis Myotis yumaensis	L	Short-tailed Weasel Mustela erminea	P
Long-legged Myotis Myotis volans	L	Long-tailed Weasel Mustela frenata	L
Small-footed Myotis Myotis subulatus	L	Black-footed Ferret Mustela nigripes	P
Silver-haired Bat Lasionycteris noctavigans	P	Mink Mustela vison	L
Western Pipistrel Pipistrellus hesperus	L	Wolverine Gulo luscus	L
Big Brown Bat Eptesicus fuscus	L	Badger Taxidea taxis	O

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT
(continued)

Species	P/L/O*	Species	P/L/O*
Spotted Skunk *Spilogale putorius*	L	White-tailed Antelope Squirrel *Ammospermophilus leucurus*	O
Striped Skunk *Mephitis mephitis*	L	Colorado Chipmunk *Eutamias quadrivittatus*	P
Coyote *Canis latrans*	O	Least Chipmunk *Eutamias minimus*	O
Red Fox *Vulpes fulva*	L	Cliff Chipmunk *Eutamias dorsalis*	L
Kit Fox *Vulpes macrotis*	P	Northern Pocket Gopher *Thomomys talpoides*	L
Gray Fox *Urocyon cinereoargenteus*	L	Apache Pocket Mouse *Perognathus apache*	O
Mountain Lion *Felis concolor*	P	Ord's Kangaroo Rat *Dipodomys ordii*	O
Bobcat *Felis rufus*	L	Beaver *Castor canadensis*	O
White-tailed Prairie Dog *Cynomys leucurus*	O	Western Harvest Mouse *Reithrodontomys megalotis*	O
Rock Squirrel *Spermophilus variegatus*	P	Canyon Mouse *Peromyscus crinitus*	L
Richardson Ground Squirrel *Spermophilus richardsoni*	P	Deer Mouse *Peromyscus maniculatus*	O
Thirteen-lined Ground Squirrel *Spermophilus tridecemlineatus*	O	Brush Mouse *Peromyscus boylei*	P
Golden-mantled Ground Squirrel *Spermophilus lateralis*	O	Pinyon Mouse *Peromyscus truei*	L

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT (continued)

Species	P/L/O*	Species	P/L/O*
Northern Grasshopper Mouse *Onychomys leucogaster*	O	Mule Deer *Odocoileus hemionus*	O
Desert Woodrat *Neotoma lepida*	O	Pronghorn *Antilocapra americana*	O
Bushy-tailed Woodrat *Neotoma cinerea*	L	Wild Horse *Equus caballas*	O
Long-tailed Vole *Microtus longicaudus*	L		
Sagebrush Vole *Lagurus curtatus*	L		
Muskrat *Ondatra zibethica*	L		
Norway Rat *Rattus norvegicus*	L		
House Mouse *Mus musculus*	O		
Porcupine *Erethizon dorsatum*	L		
White-tailed Jackrabbit *Lepus townsendi*	O		
Black-tailed Jackrabbit *Lepus californicus*	O		
Mountain Cottontail *Sylvilagus nuttalli*	L		
Desert Cottontail *Sylvilagus auduboni*	O		

APPENDIX 7

POTENTIAL AVIAN, MAMMALIAN AND REPTILIAN SPECIES OF THE PROPOSED POWER PLANT SITE AND ASSOCIATED FACILITIES IN AND NEAR THE SEEP RIDGE STUDY TRACT (continued)

Species	P/L/O*	Species	P/L/O*
Woodhouse's Toad Bufo woodhousei woodhousei	O	Desert Striped Whipsnake Masticophis taeniatus taeniatus	P
Leopard Frog Rana pipiens	L	Great Basin Gophor Snake Pituophis melanoleucus deserticola	O
Tiger Salamander Abystoma tigrinum nebulosum	L	Wandering Garter Snake Thamnophis elegans vagrans	L
Short-horned Lizard Phrynosoma douglassi ornatissimum	O	Midget Faded Rattlesnake Grotalus viridis concolor	O
Sagebrush Lizard Sceloporus graciosus graciosus	O		
Northern Tree Lizard Urosaurus ornatus wrighti	L		
Northern Side-blotched Lizard Uta stansburiana stansburiana	L		
Northern Whiptail Cnemidophorus tigris septentrionalis	O		
Western Yellow-bellied Racer Coluber constrictor mormon	L		
Utah Milk Snake Lampropeltis triangulum taylori	O		

*P = projected presence
L = literature review
O = observed

APPENDIX 8

SEEP RIDGE REGIONAL ANALYSIS
DATA CODING SHEET

Variable Name	Columns	Variable and Code
PROJECT	1	Project name 0 = Other 1 = Seep Ridge 2 = Red Wash 3 = Natural Buttes 4 = Moon Lake 5 = White River/Oil Shale (Berry and Berry) 6 = Oil Shale (LOPA) 7 = Riverbend
CATEGORY	2	Data category 0 = site 9 = nonsite
SITE	3-5	Site number (last four digits of Smithsonian trinomial)
UTMEAST	6-11	UTM Easting
UTMNORTH	12-18	UTM Northing
TYPE	19	Site type 1 = open lithic 2 = open campsite 3 = rockshelter or cave 4 = rock art 5 = quarry 6 = aboriginal structure 7 = historic Euro-American structure 8 = historic Euro-American camp or special use
TOOLS	20	Prepared chipped stone tools
FLAKES	21	Chipped stone flakes
CORES	22	Cores and/or hammerstones
GRNDSTN	23	Ground stone
SHERDS	24	Ceramics
HEARTH	25	Hearth
STONE	26	Burned stone or scattered charcoal

APPENDIX 8

SEEP RIDGE REGIONAL ANALYSIS
DATA CODING SHEET
(continued)

Variable Name	Columns	Variable and Code
BONE	27	Animal bone
DEP	28	Depression
WALL	29	Rock alignment; prehistoric masonry structure
ART	30	Rock art
HISTRUC	31	Historic structure
CORRAL	32	Corral
PGLASS	33	Purple glass or hole-in-the top cans
TRASH	34	Other historic artifacts
VANTAGE	35-37	Distance to vantage point (X.XX km)
VIEW	38-40	Viewspread (degrees)
EXPOSURE	41-43	Rescaled exposure ($0-180^{o}$)
RIVER	44-46	Distance to White or Green Rivers (XX.X km)
HEIGHT	47-49	Height above water (feet)
SIZE	50-54	Site size (square meters)
CULT 1	55	Primary cultural affiliation 1 = Paleo-Indian 2 = Archaic 3 = Fremont 4 = Ute/Shoshonean 5 = Euro-American 6 = Unknown prehistoric 7 = Archaic, Fremont or Shoshonean 8 = Fremont or Shoshonean
CULT 2	56	Secondary cultural affiliation
RELIEF	57-60	Vertical relief within ½ km radius of site (feet)
LANDFORM	61	Landform 1 = flats (plain) 2 = mesa 3 = ridge 4 = saddle 5 = bench/terrace 6 = slope (hillside or talu 7 = canyon rim 8 = valley floor/floodplain 9 = knoll or hilltop

APPENDIX 8

SEEP RIDGE REGIONAL ANALYSIS
DATA CODING SHEET
(continued)

Variable Name	Columns	Variable and Code
DUNE	62	Site association with dune 0 = no association 1 = in blowout/depression of dune 2 = edge of dune 3 = crest of dune
SHELTER	63-64	Shelter quality 0 = nonforested hilltop, ridge crest or high point 1 = flat (horizontal or sloping) non-forested area 2 = river valley floor (valleys are greater than 150 meters wide) 3 = immediately below crest of ridge or hilltop (within 50 meters) in non-forested area 4 = near forest edge (within 50 meters) but outside of forest 5 = in topographic depression such as a ravine or drainage in non-forested area 6 = clearing within forest (clearings have diameters greater than 50 meters) 7 = in forest on hilltops, flat, or sloping areas 8 = in forest, in a ravine or drainage depression 9 = in forest, immediately below (within 50 meters) crest of ridge or hilltop 10 = base of a vertical rockface scarp such as a canyon wall 11 = rockshelter or cave
SLOPE	65-66	On-site slope (% grade)
ELEV	67-70	Site elevation (feet)
WATER	71-73	Distance to nearest water (X.XX km) (river, spring, or blue-line stream)
SOURCE	74	Source of nearest water 1 = permanent stream or river 2 = intermittent (blue-line) stream 3 = seep or spring 4 = cistern

APPENDIX 8

SEEP RIDGE REGIONAL ANALYSIS
DATA CODING SHEET
(continued)

Variable Name	Columns	Variable and Code
WOOD	75-78	Distance to nearest wooded area (green shaded areas indicating juniper--not riparian--vegetation on U.S.G.S. maps) (XX.XX km)
SITEVEG	79	On-site vegetation (dominant) 1 = juniper (takes predominance over others) 2 = sagebrush 3 = saltdesert shrubs 4 = grasses (lowest on the dominance scale) 5 = riparian species 6 = barren
AREAVEG	80	Surrounding vegetation (use above codes)

APPENDIX 9

DISCRIMINANT FUNCTION ANALYSIS
INCORPORATING DATA ON
SAND DUNES AND VEGETATION

UNIVERSITY OF COLORADO COMPUTING CENTER

S P S S - - STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

VERSION 8.0 -- NOVEMBER 1, 1979

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FILE NAME       BONANZA  SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE LIST    MOONLAKE(57) REDWASH(26) MISC(10) WHITE(11) SEEP(40) NONSITE(68)
VARIABLE LIST   PROJECT CATEGORY SITE UTMEAST UTMNORTH TYPE TOOLS FLAKES CORES
                GRNDSTN SHERDS HEARTH STONE BONE DEP WALL ART HISTRUC CORRAL
                PGLASS TRASH VANTAGE VIEW EXPOSURE RIVER HEIGHT SIZE CULT1 CULT2
                RELIEF LANDFORM DUNE SHELTER SLOPE ELEV WATER SOURCE WOOD SITEVEG
                AREAVEG
INPUT FORMAT    FIXED(2F1.0.F3.0.F6.0.F7.0.16F1.0.F3.2.2F3.0.F3.1.F3.0.F5.0.
                2F1.0.F4.0.2F1.0.2F2.0.F4.0.F3.2.F1.0.F4.2.2F1.0)
```

ACCORDING TO YOUR INPUT FORMAT VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE	FORMAT	RECORD	COLUMNS
PROJECT	F 1. 0	1	1- 1
CATEGORY	F 1. 0	1	2- 2
SITE	F 3. 0	1	3- 5
UTMEAST	F 6. 0	1	6- 11
UTMNORTH	F 7. 0	1	12- 18
TYPE	F 1. 0	1	19- 19
TOOLS	F 1. 0	1	20- 20
FLAKES	F 1. 0	1	21- 21
CORES	F 1. 0	1	22- 22
GRNDSTN	F 1. 0	1	23- 23
SHERDS	F 1. 0	1	24- 24
HEARTH	F 1. 0	1	25- 25
STONE	F 1. 0	1	26- 26
BONE	F 1. 0	1	27- 27
DEP	F 1. 0	1	28- 28
WALL	F 1. 0	1	29- 29
ART	F 1. 0	1	30- 30
HISTRUC	F 1. 0	1	31- 31
CORRAL	F 1. 0	1	32- 32
PGLASS	F 1. 0	1	33- 33
TRASH	F 1. 0	1	34- 34
VANTAGE	F 3. 2	1	35- 37
VIEW	F 3. 0	1	38- 40
EXPOSURE	F 3. 0	1	41- 43
RIVER	F 3. 1	1	44- 46
HEIGHT	F 3. 0	1	47- 49
SIZE	F 5. 0	1	50- 54
CULT1	F 1. 0	1	55- 55

```
ACCORDING TO YOUR INPUT FORMAT. VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE  FORMAT  RECORD    COLUMNS

CULT2     F 1. 0      1     56-  56
RELIEF    F 4. 0      1     57-  60
LANDFORM  F 1. 0      1     61-  61
DUNE      F 1. 0      1     62-  62
SHELTER   F 2. 0      1     63-  64
SLOPE     F 2. 0      1     65-  66
ELEV      F 4. 0      1     67-  70
WATER     F 3. 2      1     71-  73
SOURCE    F 1. 0      1     74-  74
WOOD      F 4. 2      1     75-  78
SITEVEG   F 1. 0      1     79-  79
AREAVEG   F 1. 0      1     80-  80

THE INPUT FORMAT PROVIDES FOR  40 VARIABLES.   40 WILL BE READ.
IT PROVIDES FOR  1 RECORDS (*CARDS*) PER CASE.
A MAXIMUM OF    80 *COLUMNS* ARE USED ON A RECORD.

VAR LABELS      PROJECT  NAME OF SURVEY PROJECT/CATEGORY  SITE OR NON-SITE DATA/
                SITE  42UN SITE OR NON-SITE STRATUM NUMBER/GRNDSTN  GROUND STONE/
                STONE  BURNED STONE OR SCATTERED CHARCOAL/DEP  DEPRESSION/
                WALL  PREHISTORIC ROCK ALIGNMENT OR MASONRY/ART  ROCK ART/
                HISTRUC  HISTORIC STRUCTURE/PGLASS  PURPLE GLASS OR SOLDERED CAN/
                TRASH  OTHER HISTORIC ARTIFACTS/VANTAGE  KILOMETERS TO VANTAGE/
                VIEW  DEGREES OF VIEWSPREAD EXPOSURE  0 TO 180 DEGREES EXPOSURE/
                RIVER  KILOMETERS TO WHITE OR GREEN RIVERS/HEIGHT  FEET ABOVE
                PRIMARY WATER/SIZE  SITE SIZE IN SQUARE METERS/CULT1  PRIMARY
                CULTURAL AFFILIATION/CULT2  SECONDARY CULTURAL AFFILIATION/
                RELIEF  VERTICAL RELIEF WITHIN HALF-KILOMETER/DUNE  SITE ASSOC
                WITH DUNE/ELEV       FEET ABOVE SEA LEVEL/WATER  KILOMETERS TO
                PRIMARY WATER SOURCE/SOURCE  SOURCE OF PRIMARY WATER/
                WOOD  KILOMETERS TO JUNIPER AREA/SITEVEG  ON-SITE VEGETATION/
                AREAVEG  VEGETATION OF SURROUNDING AREA
MISSING VALUES  ALL(BLANK)
IF              (SITE EQ 952)VANTAGE =  0.45
IF              (SITE EQ 952)VIEW=320
IF              (SITE EQ 734)EXPOSURE=172
IF              (SITE EQ 755)EXPOSURE=167
IF              (SITE EQ 921,EXPOSUURE=98.45455
IF              (SITE EQ  743)EXPOSURE=172
IF              (SITEVEG NE AREAVEG) ECOTONE = 1
IF              (SITEVEG EQ AREAVEG) ECOTONE = 0
IF              (DUNE EQ 0) SAND = 0
IF              (DUNE NE 0) SAND = 1
IF              (PROJECT EQ 1 AND CATEGORY EQ 9)CLASS=0
IF              (PROJECT NE 1)CLASS=1
IF              (PROJECT EQ 1 AND CATEGORY EQ 0)CLASS=2
SELECT IF       (CULT1 NE 5)
RUN SUBFILES    ALL
DISCRIMINANT    GROUPS=CLASS(0.1)/VARIABLES=VANTAGE TO HEIGHT.RELIEF
                SHELTER.SLOPE.WOOD.SAND.ECOTONE/ANALYSIS=VANTAGE TO ECOTONE/
                METHOD=RAO/VIN=2.7/FIN=2.7/FOUT=2.7
OPTIONS         5,6,7,8,11.12
```

```
       STATISTICS     1,2,3,4,5,7,8
       READ INPUT DATA

00104000 CM REQUIRED FOR DISCRIMINANT ANALYSIS
00103300 CM REQUIRED FOR DISCRIMINANT CLASSIFICATION

OPTION - 5
PRINT CLASSIFICATION RESULTS TABLE

OPTION - 6
PRINT DISCRIMINANT SCORES AND CLASSIFICATION INFORMATION

OPTION - 7
PRINT A SINGLE PLOT OF CASES

OPTION - 8
PRINT A SEPARATE PLOT FOR EACH GROUP

OPTION -11
PRINT UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

OPTION -12
PRINT CLASSIFICATION FUNCTIONS
```

FILE BONANZA (CREATION DATE = 80/10/30.) SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE MOONLAKE REDWASH MISC WHITE SEEP NONSITE

- D I S C R I M I N A N T A N A L Y S I S -

ON GROUPS DEFINED BY CLASS

200 (UNWEIGHTED) CASES WERE PROCESSED.
34 OF THESE WERE EXCLUDED FROM THE ANALYSIS.
34 HAD MISSING OR OUT-OF-RANGE GROUP CODES.
0 HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
0 HAD BOTH.
166 (UNWEIGHTED) CASES WILL BE USED IN THE ANALYSIS.

NUMBER OF CASES BY GROUP

CLASS	NUMBER OF CASES UNWEIGHTED	WEIGHTED	LABEL
0	68	68.0	
1	98	98.0	
TOTAL	166	166.0	

GROUP MEANS

CLASS	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
0	.97279	188.60294	84.67647	6.98971	31.10294	175.83824	1.25000	9.94116
1	.69347	218.16327	104.91837	11.07857	27.91837	134.44898	2.71429	6.64286
TOTAL	.80789	206.05422	96.62651	9.40361	29.22289	151.40361	2.11446	7.99398

CLASS	WOOD	SAND	ECOTONE
0	8.73353	.07353	.35294
1	4.39867	.46939	.30612
TOTAL	6.17440	.30723	.32530

GROUP STANDARD DEVIATIONS

CLASS	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
0	.96343	89.32101	53.95865	5.26280	29.02451	133.78515	1.15092	13.16019
1	.60736	98.16719	48.44546	5.62103	33.42345	82.15376	3.36139	9.95169
TOTAL	.78279	95.48570	51.59145	5.82142	31.64297	107.94623	2.77524	11.45399

CLASS	WOOD	SAND	ECOTONE
0	6.06215	.26294	.48144
1	2.96482	.50163	.46325
TOTAL	4.96608	.46274	.46990

POOLED WITHIN-GROUPS COVARIANCE MATRIX WITH 164 DEGREES OF FREEDOM

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.5973902							
VIEW	2.399634	8959.217						
EXPOSURE	2.393959	12.55836	2577.611					
RIVER	1.724630	-4.114848	-13.31218	30.00310				
HEIGHT	-9.316291	380.1530	28.74763	-34.64512	1004.900			
RELIEF	-41.71605	566.0088	675.4270	-270.9346	1575.029	11304.11		
SHELTER	-.2763436	-25.53463	6.111033	-1.057470	23.55466	69.36781	7.224085	
SLOPE	-2.616630	17.71418	47.81615	-24.27932	163.6253	581.3297	-9.719512	129.3309
WOOD	-.9774404	23.55425	-5.799164	-7.168996	-5.363935	46.82139	-4.216080	6.780108
SAND	.6345389E-01	1.319970	-.8148003	.5648609	-3.291217	-11.87100	-.3908972	-.9163251
ECOTONE	-.1061671E-01	-.9980822E-01	1.891547	.2493288	1.505966	1.191542	.1803136	.3361345

	WOOD	SAND	ECOTONE
WOOD	20.21260		
SAND	.4216059	.1770763	
ECOTONE	-.2275299	.9369601E-03	.2216204

POOLED WITHIN-GROUPS CORRELATION MATRIX

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE	WOOD	SAND	ECOTONE
VANTAGE	1.00000										
VIEW	.03280	1.00000									
EXPOSURE	.06101	.00261	1.00000								
RIVER	.40737	-.00794	-.04787	1.00000							
HEIGHT	-.38024	.12670	.01786	-.19953	1.00000						
RELIEF	-.50764	.05624	.12513	-.46523	.45731	1.00000					
SHELTER	-.13302	-.10037	.04478	-.0[illegible]163	.21[illegible]45	.24274	1.00000				
SLOPE	-.25769	.01646	.08282	-.39977	.45288	.48079	.31798	1.00000			
WOOD	-.28129	.05535	-.02541	-.29193	-.03764	.09795	-.34890	.13261	1.00000		
SAND	.19510	.03314	-.03814	.24506	-.24673	-.26533	-.34561	-.19148	-.22285	1.00000	
ECOTONE	-.02918	-.00224	.07914	.09669	.10091	.02381	.14251	.06279	-.10750	.00473	1.00000

CORRELATIONS WHICH CANNOT BE COMPUTED ARE PRINTED AS 99.0.

COVARIANCE MATRIX FOR GROUP 0.

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.9282025							
VIEW	.6226185	7978.243						
EXPOSURE	10.75137	702.4517	2911.536					
RIVER	2.377253	52.28391	40.51304	27.69706				
HEIGHT	-9.944919	464.3997	91.78007	-18.3[illegible]892	842.4221			
RELIEF	-54.56581	1814.323	487.0961	-304.0121	1479.211	17898.47		
SHELTER	.1376866E-01	-14.86940	.8283592	1.9[illegible]8134	.6902985	-5.078353	1.324627	
SLOPE	-4.163863	29.24495	37.83143	-19.99912	230.1405	794.1993	-1.805970	173.1905
WOOD	-2.783134	73.58336	-29.11750	-18.23577	43.33187	263.1265	-1.725970	28.14335
SAND	.8746708E-02	3.462467	-1.229567	.4067384	1.111721	-1.629719	.1156716	-.3985953
ECOTONE	-.2532924E-01	-.8428446	5.608428	.7365233	-.2194908E-01	-1.121159	.1492537	-.1878341

	WOOD	SAND	ECOTONE
WOOD	36.74961		
SAND	-.1068306	.6913960E-01	
ECOTONE	-.3269359	.1843723E-01	.2317823

COVARIANCE MATRIX FOR GROUP

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.3688909							
VIEW	3.627057	9636.758						
EXPOSURE	-3.378683	-463.9659	2346.962					
RIVER	1.273848	-43.07069	-50.49043	31.59593				
HEIGHT	-8.882085	308.1475	-14.79024	-45.86672	1117.127			
RELIEF	-32.84044	-296.2287	805.5113	-243.0872	1041.912	6749.240		
SHELTER	-.4767305	-32.90133	9.759941	-3.1[illegible]41	39.34757	120.7894	11.29897	
SLOPE	-1.547923	9.749632	54.71281	-27.23560	117.6819	434.2960	.17.68041	99.03608
WOOD	.2697912	-11.00195	10.30731	.4412496	-38.99918	-102.5853	-5.936053	-7.975943
SAND	.1012413	-.1598990	-.5282979	.6740795	-6.332422	-18.94488	-.7407953	-1.273932
ECOTONE	-.4544498E-03	.4134231	-.6757837	-.8718704E-01	2.561330	2.788975	.2017673	.6980254

	WOOD	SAND	ECOTONE
WOOD	8.790133		
SAND	.7866085	.2516305	
ECOTONE	-.1588681	-.1115085E-01	.2146013

```
FILE    BONANZA  (CREATION DATE =  80/10/30.)   SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE   MOONLAKE   REDWASH    MISC       WHITE      SEEP       NONSITE

- - - - - - - - - - - - - - - - - - - - -  D I S C R I M I N A N T   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - -

ON GROUPS DEFINED BY CLASS


ANALYSIS NUMBER

STEPWISE VARIABLE SELECTION

     SELECTION RULE-  MAXIMIZE RAO*S V
     MAXIMUM NUMBER OF STEPS.................       22
     MINIMUM TOLERANCE LEVEL.................   .00100
     MINIMUM F TO ENTER......................   2.7000
     MAXIMUM F TO REMOVE.....................   2.7000
     MINIMUM INCREASE IN RAO*S V.............   2.7000

CANONICAL DISCRIMINANT FUNCTIONS

     MAXIMUM NUMBER OF FUNCTIONS.............        1
     MINIMUM CUMULATIVE PERCENT OF VARIANCE...  100.00
     MAXIMUM SIGNIFICANCE OF WILKS  LAMBDA....  1.0000


PRIOR PROBABILITY FOR EACH GROUP IS  .50000


------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   0 -------------

                       MINIMUM
VARIABLE   TOLERANCE   TOLERANCE   F TO ENTER    RAO*S V

VANTAGE    1.0000000   1.0000000      5.2431      5.24309
VIEW       1.0000000   1.0000000      3.9154      3.91539
EXPOSURE   1.0000000   1.0000000      6.3813      6.28134
RIVER      1.0000000   1.0000000     22.3700     22.37003
HEIGHT     1.0000000   1.0000000       .4051
RELIEF     1.0000000   1.0000000      6.0337      6.08367
SHELTER    1.0000000   1.0000000     11.9150     11.91504
SLOPE      1.0000000   1.0000000      3.3768      3.37634
WOOD       1.0000000   1.0000000     37.3211     37.32106
SAND       1.0000000   1.0000000     35.5260     35.52598
ECOTONE    1.0000000   1.0000000       .3971
```

* *

AT STEP 1, WOOD WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.8146192	1	1	164.0		
EQUIVALENT F	37.32106		1	164.0	.0000	
RAO*S V	37.32106		1		.0000 (APPROX.)	

---------------- VARIABLES IN THE ANALYSIS AFTER STEP 1 ----------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
WOOD	1.0000000	37.3211	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP 1 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VANTAGE	.9208775	.9208775	14.1252	54.76703
VIEW	.9969363	.9969363	4.3595	42.70548
EXPOSURE	.9993545	.9993545	4.5542	42.94595
RIVER	.9147787	.9147787	7.6830	46.81036
HEIGHT	.9985835	.9985835	.6087	
RELIEF	.9904053	.9904053	2.8529	40.84470
SHELTER	.8782658	.8782658	1.6071	
SLOPE	.9824147	.9824147	.8701	
SAND	.9503373	.9503373	45.6725	93.73111
ECOTONE	.9884430	.9884430	1.3565	

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP 1
EACH F STATISTIC HAS 1 AND 164.0 DEGREES OF FREEDOM.

GROUP	GROUP 0
1	37.321 .0000

* *

AT STEP 2, SAND WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.6363221	2	1	164.0		
EQUIVALENT F	46.57979		2	163.0	.0000	
RAO*S V	93.73111		2		.0000 (APPROX.)	

--------------- VARIABLES IN THE ANALYSIS AFTER STEP 2 ---------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
WOOD	.9503373	47.5499	
SAND	.9503373	45.6725	

------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP 2 -------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VANTAGE	.8509535	.8406917	26.5406	135.95549
VIEW	.9964808	.9480340	2.9337	98.39842
EXPOSURE	.9982447	.9492819	4.3260	100.61353
RIVER	.8135787	.8135787	.2397	
HEIGHT	.9388097	.8934514	.6297	
RELIEF	.9036350	.8670773	.0825	
SHELTER	.8027675	.8027675	8.9666	107.99634
SLOPE	.9310075	.9006086	.3080	
ECOTONE	.9875770	.9385523	1.4472	

F ST STICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP 2
EAC .TATISTIC HAS 2 AND 163.0 DEGREES OF FREEDOM.

GROUP 0

G .

46.580
.0000

* *

AT STEP 3, VANTAGE WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.546747B	3	1	164.0		
EQUIVALENT F	44.76583		3	162.0	0	
RAO*S V	135.9555		3		0 (APPROX.)	

---------------- VARIABLES IN THE ANALYSIS AFTER STEP 3 ----------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
VANTAGE	.8509535	26.5406	
WOOD	.8406917	67.2997	
SAND	.8781764	60.1212	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP 3 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VIEW	.9943355	.8374532	3.2602	142.02951
EXPOSURE	.9936293	.8406530	5.0667	145.39507
RIVER	.7452516	.7452516	3.6641	142.78204
HEIGHT	.8137873	.7376310	1.1628	
RELIEF	.7135419	.6719428	4.6595	144.63649
SHELTER	.7732419	.7420092	3.5689	142.60468
SLOPE	.8037980	.8078034	.3294	
ECOTONE	.9822704	.8265837	2.1450	

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP 3
EACH F STATISTIC HAS 3 AND 152.0 DEGREES OF FREEDOM.

GROUP	GROUP 0
1	44.766 .0000

* *

AT STEP   4, EXPOSURE WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.5300666	4	1	164.0		
EQUIVALENT F	35.68385		4	161.0	.0000	
RAO*S V	145.3951		4		0 (APPROX.)	

--------------- VARIABLES IN THE ANALYSIS AFTER STEP   4 ---------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
VANTAGE	.8470191	27.2466	
EXPOSURE	.9936293	5.0667	
WOOD	.9406530	64.4267	
SAND	.8759064	59.8194	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   4 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VIEW	.9943330	.8374159	3.1286	151.44500
RIVER	.7413270	.7413270	4.1805	153.47897
HEIGHT	.8127057	.7333048	1.2991	
RELIEF	.6916691	.6584637	6.4767	157.91915
SHELTER	.7717549	.7416689	3.0946	151.37908
SLOPE	.8750198	.8014139	.6201	
ECOTONE	.9754472	.8263281	2.6483	

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   4
EACH F STATISTIC HAS   4 AND   161.0 DEGREES OF FREEDOM.

GROUP	GROUP 0
1	35.684 .0000

* *

AT STEP   5, RELIEF   WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.5094447	5	1	164.0		
EQUIVALENT F	30.81349		5	160.0	.0000	
RAO*S V	157.9192		5			0 (APPROX.)

---------------- VARIABLES IN THE ANALYSIS AFTER STEP   5 ----------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
VANTAGE	.6584637	34.6491	
EXPOSURE	.9631707	6.8859	
RELIEF	.6916691	6.4767	
WOOD	.8406457	60.4062	
SAND	.8463962	44.2324	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   5 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VIEW	.9857460	.6537430	3.8741	165.76280
RIVER	.6715483	.6265645	1.6841	
HEIGHT	.7294587	.6208202	.1126	
SHELTER	.7525142	.6517540	4.5741	167.18010
SLOPE	.7513909	.5939453	.0318	
ECOTONE	.9754458	.6552114	2.5383	

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   5
EACH F STATISTIC HAS   5 AND   160.0 DEGREES OF FREEDOM.

GROUP	GROUP 0
1	30.813 .0000

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AT STEP   6, SHELTER  WAS INCLUDED IN THE ANALYSIS.

                                        DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA           .4951988     6     1      164.0
EQUIVALENT F            27.01386           6      159.0    .0000

RAO*S V                 167.1801           6                    0 (APPROX.)

---------------- VARIABLES IN THE ANALYSIS AFTER STEP   6 ----------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

VANTAGE     .6517540    29.7421
EXPOSURE    .9629313     6.4609
RELIEF      .6744251     7.9662
SHELTER     .7525142     4.5741
WOOD        .7392098    35.2348
SAND        .8094097    48.5485

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   6 --------------

                        MINIMUM
VARIABLE   TOLERANCE   TOLERANCE   F TO ENTER    RAO*S V

VIEW        .9772092    .6480622      4.5767    176.77332
RIVER       .6715412    .6125608      1.6441
HEIGHT      .7176920    .6131633       .3619
SLOPE       .6915356    .5928043       .1898
ECOTONE     .9625021    .6494943      3.3018    174.10101

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   6
EACH F STATISTIC HAS   6 AND      159.0 DEGREES OF FREEDOM.

                 GROUP        0

   GROUP

      1                    27.014
                            .0000
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AT STEP   7, VIEW      WAS INCLUDED IN THE ANALYSIS.

                                      DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA           .4812583      7    1      164.0
EQUIVALENT F           24.32943            7      158.0    .0000

RAO*S V                176.7733            7                  0 (APPROX.)

--------------- VARIABLES IN THE ANALYSIS AFTER STEP   7 ---------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

VANTAGE     .6480622     30.6098
VIEW        .9772092      4.5767
EXPOSURE    .9627596      6.3813
RELIEF      .6667454      8.9886
SHELTER     .7459972      5.2755
WOOD        .7387072     34.6520
SAND        .8093903     46.2772

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   7 -------------

                       MINIMUM
VARIABLE   TOLERANCE  TOLERANCE   F TO ENTER     RAO*S V

RIVER       .6713503   .6055752     1.5000
HEIGHT      .6994247   .6113173      .8810
SLOPE       .6913381   .5875294      .2150
ECOTONE     .9625125   .6457273     3.3211     183.98192


F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   7
EACH F STATISTIC HAS   7 AND     158.0 DEGREES OF FREEDOM.

                 GROUP        0

   GROUP

      1                    24.329
                            .0000
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AT STEP   8, ECOTONE  WAS INCLUDED IN THE ANALYSIS.

                                          DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA          .4712889    8     1       164.0
EQUIVALENT F           22.01613          8       157.0    .0000

RAO*S V                183.9819          8                     0 (APPROX.)

---------------- VARIABLES IN THE ANALYSIS AFTER STEP   8 ----------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

VANTAGE     .6457273     31.0933
VIEW        .9769153      4.5883
EXPOSURE    .9564051      6.9594
RELIEF      .6664511      8.9771
SHELTER     .7361378      6.0905
WOOD        .7334207     35.6885
SAND        .8048511     47.1202
ECOTONE     .9625125      3.3211

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   8 --------------

                        MINIMUM
VARIABLE   TOLERANCE   TOLERANCE   F TO ENTER    RAO*S V

RIVER       .6647149    .6055130      1.9426
HEIGHT      .6955043    .6102497       .6297
SLOPE       .6902198    .5868661       .1486


F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   8
EACH F STATISTIC HAS   8 AND      157.0 DEGREES OF FREEDOM.

                 GROUP        0

   GROUP

       1                  22.016
                           .0000

F LEVEL OR TOLERANCE OR VIN INSUFFICIENT FOR FURTHER COMPUTATION.
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SUMMARY TABLE

STEP	ACTION ENTERED REMOVED	VARS IN	WILKS LAMBDA	SIG.	RAO*S V	SIG.	CHANGE IN V	SIG.	LABEL
1	WOOD	1	.814619	.0000	37.3211	.0000	37.3211	.0000	KILOMETERS TO JUNIPER AREA
2	SAND	2	.636322	.0000	93.7311	.0000	56.4101	.0000	
3	VANTAGE	3	.546748	.0000	135.9555	0	42.2244	.0000	KILOMETERS TO VANTAGE
4	EXPOSURE	4	.530067	.0000	145.3951	0	9.4396	.0021	0 TO 180 DEGREES EXPOSURE
5	RELIEF	5	.509445	0	157.9192	0	12.5241	.0004	VERTICAL RELIEF WITHIN HALF-KILOMETER
6	SHELTER	6	.495199	.0000	167.1801	0	9.2610	.0023	
7	VIEW	7	.481258	0	176.7733	0	9.5932	.0020	DEGREES OF VIEWSPREAD
8	ECOTONE	8	.471269	.0000	183.9819	0	7.2086	.0073	

CLASSIFICATION FUNCTION COEFFICIENTS
(FISHER*S LINEAR DISCRIMINANT FUNCTIONS)

CLASS =	0	1
VANTAGE	4.610843	2.683505
VIEW	.1795672E-01	.2325972E-01
EXPOSURE	.2121794E-01	.3343465E-01
RELIEF	.2372164E-01	.1583292E-01
SHELTER	.5295438	.7762643
WOOD	.7212758	.3921867
SAND	-.2409492	3.506083
ECOTONE	1.823564	.9060689
(CONSTANT)	-11.40666	-9.856726

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	PERCENT OF VARIANCE	CUMULATIVE PERCENT	CANONICAL CORRELATION	- AFTER - FUNCTION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIGNICANCE
					- 0	.4712889	120.37	8	.0000
1*	1.12184	100.00	100.00	.7271253	-				

* MARKS THE 1 FUNCTION(S) TO BE USED IN THE REMAINING ANALYSIS.

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
VANTAGE	.69585
VIEW	-.23447
EXPOSURE	-.28973
RELIEF	.39179
SHELTER	-.30976
WOOD	.69112
SAND	[illegible]

UNSTANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
VANTAGE	.9002927
VIEW	-.2477122E-02
EXPOSURE	-.5706636E-02
RELIEF	.3684960E-02
SHELTER	-.1152474
WOOD	.1537232
SAND	-1.750303
ECOTONE	.4285780
(CONSTANT)	-.5305572

CANONICAL DISCRIMINANT FUNCTIONS EVALUATED AT GROUP MEANS (GROUP CENTROIDS)

GROUP	FUNC 1
0	1.26384
1	-.87695

TEST OF EQUALITY OF GROUP COVARIANCE MATRICES USING BOX*S M

THE RANKS AND NATURAL LOGARITHMS OF DETERMINANTS PRINTED ARE THOSE OF THE GROUP COVARIANCE MATRICES.

GROUP LABEL	RANK	LOG DETERMINANT
0	8	25.327891
1	8	24.531348
POOLED WITHIN-GROUPS COVARIANCE MATRIX	8	26.565583

BOX*S M	APPROXIMATE F	DEGREES OF FREEDOM		SIGNIFICANCE
283.53	7.4502	36.	70177.4	.0000

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
MOONLAKE	1			1.	***	0	.6916	.8088	1	.1912	.8672
MOONLAKE	2			1.		1	.2821	.9900	0	.0100	-1.9526
MOONLAKE	3			1.		1	.7812	.9471	0	.0529	-1.1546
MOONLAKE	4			1.		1	.1950	.9937	0	.0063	-2.1728
MOONLAKE	5			1.		1	.5645	.9696	0	.0304	-1.4238
MOONLAKE	6			1.		1	.3470	.5691	0	.4309	.0635
MOONLAKE	7			1.	***	0	.4013	.6212	1	.3788	.4245
MOONLAKE	8			1.		1	.2920	.9895	0	.0105	-1.9306
MOONLAKE	9			1.	***	0	.5594	.7392	1	.2608	.6801
MOONLAKE	11			1.		1	.4947	.9771	0	.0229	-1.5599
MOONLAKE	12			1.	***	0	.7253	.5247	1	.1753	.9169
MOONLAKE	13			1.		1	.6116	.7693	0	.2307	-.3691
MOONLAKE	14			1.		1	.4568	.6679	0	.3321	-.1329
MOONLAKE	15			1.		1	.5950	.7601	0	.2399	-.3453
MOONLAKE	16			1.		1	.3988	.9837	0	.0163	-1.7208
MOONLAKE	17			1.	***	0	.4175	.6355	1	.3645	.4531
MOONLAKE	18			1.		1	.6817	.8043	0	.1957	-.4668
MOONLAKE	20			1.		1	.8366	.9389	0	.0611	-1.0831
MOONLAKE	21			1.	***	0	.7546	.8351	1	.1649	.9513
MOONLAKE	22			1.		1	.3291	.5504	0	.4496	.0990
MOONLAKE	23			1.		1	.7133	.8183	0	.1817	-.5095
MOONLAKE	24			1.		1	.6347	.9647	0	.0353	-1.3520
MOONLAKE	25			1.		1	.5412	.7278	0	.2722	-.2660
MOONLAKE	26			1.		1	.2211	.9927	0	.0073	-2.1007
MOONLAKE	27			1.		1	.9766	.9133	0	.0867	-.9063
MOONLAKE	28			1.		1	.4313	.6472	0	.3528	-.0900
MOONLAKE	29			1.		1	.8156	.8572	0	.1428	-.6437
MOONLAKE	30			1.		1	.3021	.9890	0	.0110	-1.9089
MOONLAKE	31			1.		1	.8163	.9421	0	.0579	-1.1092
MOONLAKE	32			1.		1	.7098	.8168	0	.1832	-.5048
MOONLAKE	33			1.		1	.3687	.9855	0	.0145	-1.7758
MOONLAKE	34			1.		1	.9554	.8977	0	.1023	-.8211
MOONLAKE	35			1.		1	.2490	.9915	0	.0085	-2.0296
MOONLAKE	36			1.		1	.5041	.9764	0	.0236	-1.5450
MOONLAKE	37			1.		1	.3310	.5524	0	.4476	.0951
MOONLAKE	38			1.		1	.4526	.9801	0	.0199	-1.6280
MOONLAKE	39			1.		1	.7519	.8341	0	.1659	-.5608
MOONLAKE	40			1.		1	.1362	.9959	0	.0041	-2.3671
MOONLAKE	41			1.		1	.4898	.6927	0	.3073	-.1862
MOONLAKE	42			1.		1	.8476	.8676	0	.1324	-.6848
MOONL AE	43			1.		1	.3704	.5924	0	.4076	.0188
MOON E	44			1.		1	.9407	.9206	0	.0794	-.9514
MOO	45			1.		1	.2258	.9925	0	.0075	-2.0882
MOO	46			1.		1	.5250	.9747	0	.0253	-1.5127
MOO	47			1.		1	.7097	.8168	0	.1832	-.5047
MOON	48			1.	***	0	.8269	.8610	1	.1390	1.0451
MOON	50			1.		1	.2786	.9902	0	.0098	-1.9603
MOON	51			1.		1	.6224	.9660	0	.0340	-1.3694
MOON	52			1.		1	.5159	.7111	0	.2889	-.2272
MOON	53			1.		1	.8894	.9302	0	.0698	-1.0160
MOON	54			1.		1	.3342	.9874	[illegible]	.0126	-1.8427
MOO	55			1		1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
REDWASH	1			1.		1	.3525	.9864	0	.0136	-1.8068
REDWASH	2			1.	***	0	.5044	.7032	1	.2968	.5963
REDWASH	3			1.		1	.6508	.7896	0	.2104	-.4243
REDWASH	4			1.		1	.3148	.9884	0	.0116	-1.8821
REDWASH	6			1.		1	.7981	.8512	0	.1488	-.6212
REDWASH	7			1.		1	.0765	.9977	0	.0023	-2.6482
REDWASH	8			1.		1	.9680	.9151	0	.0849	-.9170
REDWASH	9			1.	***	0	.7475	.8323	1	.1677	.9419
REDWASH	10			1.		1	.1979	.9936	0	.0064	-2.1645
REDWASH	11			1.		1	.3857	.6069	0	.3931	-.0095
REDWASH	12			1.		1	.6613	.7947	0	.2053	-.4388
REDWASH	13			1.		1	.8684	.8740	0	.1260	-.7112
REDWASH	14			1.		1	.8361	.8640	0	.1360	-.6701
REDWASH	15			1.		1	.9195	.9247	0	.0753	-.9780
REDWASH	16			1.		1	.4977	.6984	0	.3016	-.1988
REDWASH	17			1.		1	.9758	.9135	0	.0865	-.9073
REDWASH	18			1.		1	.7641	.9495	0	.0505	-1.1770
REDWASH	19			1.		1	.8299	.9400	0	.0600	-1.0918
REDWASH	20			1.		1	.8368	.8642	0	.1358	-.6709
REDWASH	21			1.	***	0	.4639	.6734	1	.3266	.5314
REDWASH	22			1.		1	.9935	.9096	0	.0904	-.8851
REDWASH	23			1.		1	.0514	.9984	0	.0016	-2.8254
REDWASH	24			1.		1	.8651	.8730	0	.1270	-.7071
REDWASH	25			1.		1	.5270	.9746	0	.0254	-1.5095
REDWASH	26			1.		1	.8744	.9328	0	.0672	-1.0351
MISC	1			1.		1	.6512	.9630	0	.0370	-1.3290
MISC	2			1.		1	.7029	.8138	0	.1862	-.4956
MISC	3			1.		1	.6768	.9602	0	.0398	-1.2938
MISC	4			1.		1	.5893	.9691	0	.0309	-1.4167
MISC	5			1.		1	.9073	.9269	0	.0731	-.9934
MISC	6			1.		1	.1111	.9967	0	.0033	-2.4702
MISC	7			1.		1	.2945	.9894	0	.0106	-1.9253
MISC	9			1.		1	.6563	.9625	0	.0375	-1.3220
MISC	10			1.		1	.2013	.9935	0	.0065	-2.1548
WHITE	1			1.		1	.6997	.9576	0	.0424	-1.2627
WHITE	2			1.		1	.9860	.9113	0	.0887	-.8945
WHITE	3			1.		1	.9239	.8896	0	.1104	-.7815
WHITE	4			1.		1	.2993	.9892	0	.0108	-1.9148
WHITE	5			1.		1	.3169	.5371	0	.4629	.1239
WHITE	6			1.		1	.6203	.7740	0	.2260	-.3815
WHITE	7			1.		1	.8232	.8597	0	.1403	-.6535
WHITE	8			1.		1	.4567	.9799	0	.0201	-1.6213
WHITE	9			1.		1	.7931	.8494	0	.1506	-.6147
WHITE	10			1.		1	.4279	.6443	0	.3557	-.0841
WHITE	11			1.		1	.6063	.7664	0	.2336	-.3616
SEEP	4			UNGRPD		1	.0678	.9980	0	.0020	-2.7035
SEEP	5			UNGRPD		1	.8059	.9436	0	.0564	-1.1227
SEEP	6			UNGRPD		1	.8333	.9395	0	.0605	-1.0874
SEEP	7			UNGRPD		1	.6270	.7775	0	.2225	-.3910
SEEP	8			UNGRPD		1	.5603	.7398	0	.2602	-.2946
SEEP	10			UNGRPD		0	.7914	.9457	1	.0543	1.5284
SEEP	11			UNGRPD		1	.7615	.8378	0	.1622	-.5735
SEEP	12			UNGRPD		1	.2313	.9923	0	.0077	-2.0739

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST GROUP	PROBABILITY P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
SEEP	13			UNGRPD	1	.6877	.9590	0	.0410	-1.2789
SEEP	15			UNGRPD	1	.3261	.5472	0	.4528	.1050
SEEP	16			UNGRPD	1	.3300	.9876	0	.0124	-1.8510
SEEP	17			UNGRPD	1	.9071	.8851	0	.1149	-.7603
SEEP	18			UNGRPD	1	.4751	.9785	0	.0215	-1.5911
SEEP	19			UNGRPD	1	.6214	.9661	0	.0339	-1.3708
SEEP	20			UNGRPD	1	.6456	.9636	0	.0364	-1.3368
SEEP	21			UNGRPD	1	.3590	.5812	0	.4188	.0403
SEEP	22			UNGRPD	1	.4904	.6932	0	.3068	-.1873
SEEP	23			UNGRPD	1	.7293	.8250	0	.1750	-.5310
SEEP	24			UNGRPD	1	.6156	.7715	0	.2285	-.3748
SEEP	25			UNGRPD	1	.5404	.9735	0	.0265	-1.4891
SEEP	26			UNGRPD	1	.1731	.9946	0	.0054	-2.2394
SEEP	27			UNGRPD	1	.2125	.9930	0	.0070	-2.1238
SEEP	28			UNGRPD	1	.3471	.9867	0	.0133	-1.8172
SEEP	29			UNGRPD	1	.6348	.9647	0	.0353	-1.3519
SEEP	30			UNGRPD	1	.3106	.9886	0	.0114	-1.8910
SEEP	31			UNGRPD	1	.8973	.8824	0	.1176	-.7479
SEEP	32			UNGRPD	1	.6584	.9622	0	.0378	-1.3191
SEEP	33			UNGRPD	1	.9906	.9060	0	.0940	-.8651
SEEP	34			UNGRPD	1	.9361	.9215	0	.0785	-.9572
SEEP	35			UNGRPD	1	.6802	.8036	0	.1964	-.4648
SEEP	36			UNGRPD	1	.0177	.9994	0	.0006	-3.2492
SEEP	38			UNGRPD	1	.1873	.9940	0	.0060	-2.1956
SEEP	39			UNGRPD	1	.0454	.9986	0	.0014	-2.8776
SEEP	40			UNGRPD	1	.9455	.8955	0	.1045	-.8098
NONSITE	1			0 ***	1	.2869	.5030	0	.4970	.1879
NONSITE	2			0	0	.1993	.9936	1	.0064	2.5474
NONSITE	3			0	0	.1854	.9941	1	.0059	2.5882
NONSITE	4			0	0	.2240	.9926	1	.0074	2.4799
NONSITE	5			0	0	.9582	.9151	1	.0849	1.3037
NONSITE	6			0	0	.4004	.9836	1	.0164	2.1048
NONSITE	7			0	0	.8597	.9336	1	.0664	1.4279
NONSITE	8			0	0	.2509	.9914	1	.0086	2.4120
NONSITE	9			0	0	.2411	.9918	1	.0082	2.4360
NONSITE	10			0	0	.0125	.9995	1	.0005	3.7612
NONSITE	11			0	0	.0060	.9997	1	.0003	4.0137
NONSITE	12			0	0	.4069	.9832	1	.0168	2.0932
NONSITE	13			0	0	.2972	.5149	1	.4851	.2213
NONSITE	14			0	0	.7296	.8251	1	.1749	.9182
NONSITE	15			0 ***	1	.5429	.7289	0	.2711	-.2685
NONSITE	16			0	0	.2199	.9927	1	.0073	2.4907
NONSITE	17			0	0	.2823	.9900	1	.0100	2.3390
NONSITE	18			0	0	.8319	.8626	1	.1374	1.0516
NONSITE	19			0	0	.0275	.9991	1	.0009	3.4685
NONSITE	20			0	0	.8619	.9349	1	.0651	1.4378
NONSITE	21			0	0	.8487	.8680	1	.1320	1.0731
NONSITE	22			0	0	.6059	.7662	1	.2338	.7479
NONSITE	23			0	0	.2419	.9918	1	.0082	2.4342
NONSITE	24			0	0	.2868	.5028	1	.4972	.1987
NONSITE	25			0	0	.3306	.5520	1	.4480	.2910
NONSITE	26			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST GROUP	PROBABILITY P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
NONSITE	28			0	0	.3984	.6186	1	.3814	.4193
NONSITE	29			0 ***	1	.4671	.6759	0	.3241	-.1498
NONSITE	30			0	0	.5126	.7089	1	.2911	.6091
NONSITE	31			0	0	.7492	.8330	1	.1670	.9441
NONSITE	32			0	0	.8733	.9330	1	.0670	1.4234
NONSITE	33			0 ***	1	.5996	.7627	0	.2373	-.3520
NONSITE	34			0	0	.5811	.7522	1	.2478	.7121
NONSITE	35			0	0	.6586	.7934	1	.2066	.8219
NONSITE	36			0	0	.3243	.9879	1	.0121	2.2495
NONSITE	37			0	0	.3173	.9883	1	.0117	2.2639
NONSITE	38			0	0	.6096	.9672	1	.0328	1.7745
NONSITE	39			0	0	.1369	.9958	1	.0042	2.7513
NONSITE	40			0	0	.4681	.6766	1	.3234	.5383
NONSITE	41			0	0	.6636	.7958	1	.2042	.8289
NONSITE	42			0	0	.3903	.6112	1	.3888	.4048
NONSITE	43			0 ***	1	.3232	.5440	0	.4560	.1110
NONSITE	44			0	0	.1901	.9939	1	.0061	2.5742
NONSITE	45			0 ***	1	.5000	.7000	0	.3000	-.2024
NONSITE	46			0	0	.9832	.9119	1	.0881	1.2849
NONSITE	47			0	0	.4129	.6315	1	.3685	.4451
NONSITE	48			0	0	.8808	.9317	1	.0683	1.4138
NONSITE	49			0	0	.4603	.9796	1	.0204	2.0021
NONSITE	50			0	0	.8867	.8794	1	.1206	1.1214
NONSITE	51			0	0	.8125	.8561	1	.1439	1.0266
NONSITE	52			0	0	.9028	.9278	1	.0722	1.3659
NONSITE	53			0	0	.6694	.9610	1	.0390	1.6908
NONSITE	54			0	0	.2186	.9928	1	.0072	2.4942
NONSITE	55			0	0	.9841	.8786	1	.1214	1.1181
NONSITE	56			0	0	.3362	.9873	1	.0127	2.2256
NONSITE	57			0	0	.9352	.8926	1	.1074	1.1825
NONSITE	58			0 ***	1	.5674	.7441	0	.2559	-.3050
NONSITE	59			0 ***	1	.9860	.9113	0	.0887	-.8945
NONSITE	60			0	0	.5714	.7465	1	.2535	.6978
NONSITE	61			0	0	.1695	.9947	1	.0053	2.6378
NONSITE	62			0	0	.6290	.9653	1	.0347	1.7469
NONSITE	63			0 ***	1	.7418	.9524	0	.0476	-1.2064
NONS	64			0	0	.9557	.9216	1	.0784	1.3446
NONS	65			0 ***	1	.2614	.9909	0	.0091	-1.9999
NONS	66			0	0	.7655	.9493	1	.0507	1.5622
NONS	67			0	0	.5433	.7291	1	.2709	.6560
NONS	68			0	0	.8044	.9438	1	.0562	1.5115

SYMB USED IN PLOTS

SYMBOL	GROUP	LABEL
1	0	
2	1	
"		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              16 +                                                                                 +
                 .                                                                                 .
                 .                                                                                 .
F                .                                                                                 .
R             12 +                                                                                 +
E                .                                     2                                           .
Q                .                                   2 2                                           .
U                .                                   2 22                                          .
E              8 +                              2    2 22                                          +
N                .                              2    2 22 2      1    1                            .
C                .                              2 22 2222221   1 1    1                            .
Y                .                              222?22222221   1 1    1                            .
               4 +                             2222?22?22221 11211   111                           +
                 .                             ?2?2?22?2?1211212111  111                           .
                 .                          ? 2?2?2?????1?21221211111111                           .
                 .                        ? 222?1???1?1?1??2222211?111111   1 11                   .
                OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                           -6        -4        -2         0         2         4         6
GROUP CENTROIDS                                       2          1
```

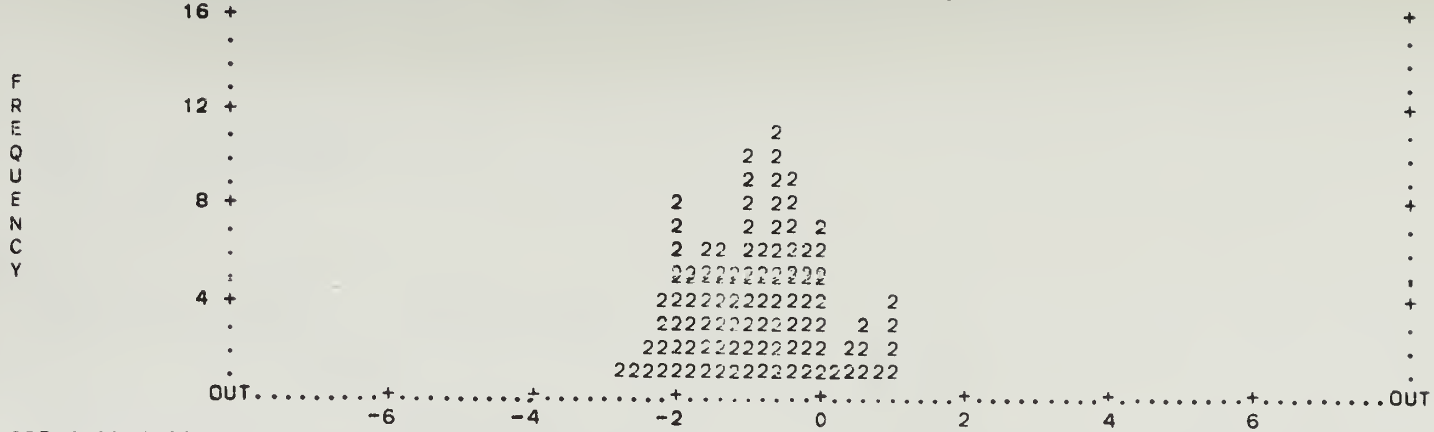
HISTOGRAM FOR GROUP 0

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
               8 +                                                                                 +
                 .                                                                                 .
                 .                                               1    1                            .
F                .                                               1    1                            .
R              6 +                                         1   1 1    1                            +
E                .                                         1   1 1    1                            .
Q                .                                         1   1 1    1                            .
U                .                                         1   1 1    1                            .
E              4 +                                         1 11111   111                           +
N                .                                         1 11111   111                           .
C                .                                       1 11111111  111                           .
Y                .                                       1 11111111  111                           .
               2 +                                      11 1111111111111                           +
                 .                                      11 1111111111111                           .
                 .                              1   1 1 11 11111111111111   1 11                   .
                 .                              1   1 1 11 11111111111111   1 11                   .
                OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                           -6        -4        -2         0         2         4         6
GROUP CENTROIDS                                                  1
```

HISTOGRAM FOR GROUP 1

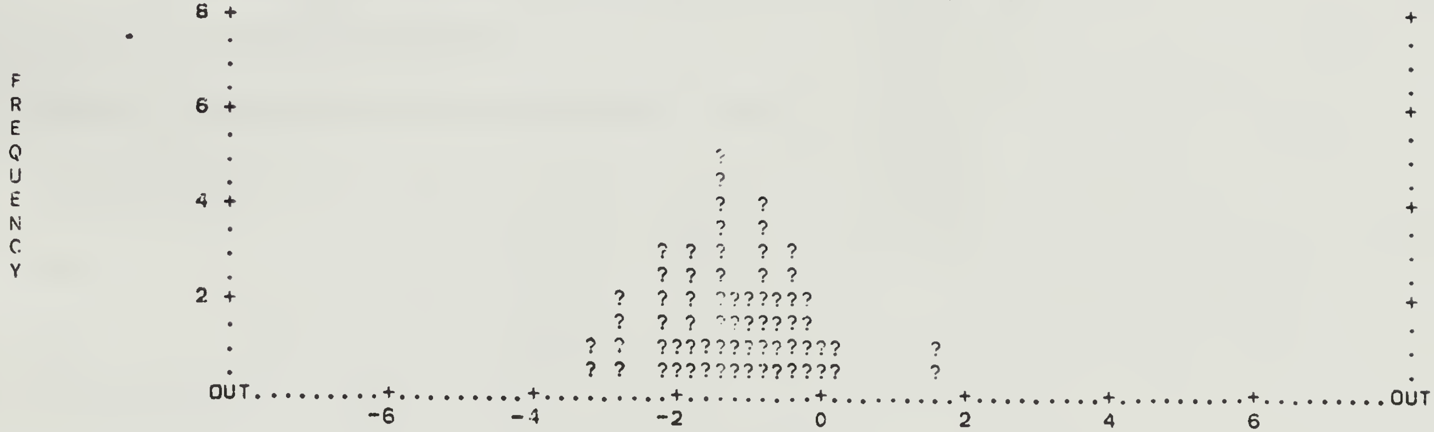
-- CANONICAL DISCRIMINANT FUNCTION 1 --



GROUP CENTROIDS 2

HISTOGRAM FOR UNGROUPED CASES

-- CANONICAL DISCRIMINANT FUNCTION 1 --



CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP 0	1
GROUP 0	68	58	10
		85.3	14.7
GROUP 1	98	10	88
		10.2	89.8
UNGROUPED CASES	34	1	33
		2.9	97.1

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 87.95

CLASSIFICATION PROCESSING SUMMARY

200 CASES WERE PROCESSED.
0 CASES HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
200 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.   8.3260 SECONDS

FINISH

TOTAL CPU TIME USED..   9.4850 SECONDS

RUN COMPLETED

NUMB OF CONTROL CARDS READ   47
NUMB OF ERRORS DETECTED   0

APPENDIX 10

DISCRIMINANT FUNCTION ANALYSIS
UTILIZING DATA AVAILABLE
FROM U.S.G.S. TOPOGRAPHIC MAPS

UNIVERSITY OF COLORADO COMPUTING CENTER

S P S S - - STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

VERSION 8.0 -- NOVEMBER 1, 1979

```
FILE NAME       BONANZA  SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE LIST    MOONLAKE(57) REDWASH(26) MISC(10) WHITE(11) SEEP(40) NONSITE(68)
VARIABLE LIST   PROJECT CATEGORY SITE UTMEAST UTMNORTH TYPE TOOLS FLAKES CORES
                GRNDSTN SHERDS HEARTH STONE BONE DEP WALL ART HISTRUC CORRAL
                PGLASS TRASH VANTAGE VIEW EXPOSURE RIVER HEIGHT SIZE CULT1 CULT2
                RELIEF LANDFORM DUNE SHELTER SLOPE ELEV WATER SOURCE WOOD SITEVEG
                AREAVEG
INPUT FORMAT    FIXED(2F1.0.F3.0.F6.0.F7.0.16F1.0.F3.2.2F3.0.F3.1.F3.0.F5.0.
                2F1.0.F4.0.2F1.0.2F2.0.F4.0.F3.2.F1.0.F4.2.2F1.0)
```

ACCORDING TO YOUR INPUT FORMAT. VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE	FORMAT	RECORD	COLUMNS
PROJECT	F 1. 0	1	1- 1
CATEGORY	F 1. 0	1	2- 2
SITE	F 3. 0	1	3- 5
UTMEAST	F 6. 0	1	6- 11
UTMNORTH	F 7. 0	1	12- 18
TYPE	F 1. 0	1	19- 19
TOOLS	F 1. 0	1	20- 20
FLAKES	F 1. 0	1	21- 21
CORES	F 1. 0	1	22- 22
GRNDSTN	F 1. 0	1	23- 23
SHERDS	F 1. 0	1	24- 24
HEARTH	F 1. 0	1	25- 25
STONE	F 1. 0	1	26- 26
BONE	F 1. 0	1	27- 27
DEP	F 1. 0	1	28- 28
WALL	F 1. 0	1	29- 29
ART	F 1. 0	1	30- 30
HISTRUC	F 1. 0	1	31- 31
CORRAL	F 1. 0	1	32- 32
PGLASS	F 1. 0	1	33- 33
TRASH	F 1. 0	1	34- 34
VANTAGE	F 3. 2	1	35- 37
VIEW	F 3. 0	1	38- 40
EXPOSURE	F 3. 0	1	41- 43
RIVER	F 3. 1	1	44- 46
HEIGHT	F 3. 0	1	47- 49
SIZE	F 5. 0	1	50- 54
CULT1	F 1. 0	1	55- 55

```
ACCORDING TO YOUR INPUT FORMAT. VARIABLES ARE TO BE READ AS FOLLOWS

VARIABLE  FORMAT  RECORD    COLUMNS

CULT2     F 1. 0       1    56-  56
RELIEF    F 4. 0       1    57-  60
LANDFORM  F 1. 0       1    61-  61
DUNE      F 1. 0       1    62-  62
SHELTER   F 2. 0       1    63-  64
SLOPE     F 2. 0       1    65-  66
ELEV      F 4. 0       1    67-  70
WATER     F 3. 2       1    71-  73
SOURCE    F 1. 0       1    74-  74
WOOD      F 4. 2       1    75-  78
SITEVEG   F 1. 0       1    79-  79
AREAVEG   F 1. 0       1    80-  80

THE INPUT FORMAT PROVIDES FOR  40 VARIABLES.   40 WILL BE READ.
IT PROVIDES FOR  1 RECORDS (*CARDS*) PER CASE.
A MAXIMUM OF    80 *COLUMNS* ARE USED ON A RECORD.

VAR LABELS      PROJECT  NAME OF SURVEY PROJECT/CATEGORY  SITE OR NON-SITE DATA/
                SITE  42UN SITE OR NON-SITE STRATUM NUMBER/GRNDSTN  GROUND STONE/
                STONE  BURNED STONE OR SCATTERED CHARCOAL/DEP  DEPRESSION/
                WALL  PREHISTORIC ROCK ALIGNMENT OR MASONRY/ART  ROCK ART/
                HISTRUC  HISTORIC STRUCTURE/PGLASS  PURPLE GLASS OR SOLDERED CAN/
                TRASH  OTHER HISTORIC ARTIFACTS/VANTAGE  KILOMETERS TO VANTAGE/
                VIEW  DEGREES OF VIEWSPREAD/EXPOSURE  0 TO 180 DEGREES EXPOSURE/
                RIVER  KILOMETERS TO WHITE OR GREEN RIVERS/HEIGHT  FEET ABOVE
                PRIMARY WATER/SIZE  SITE SIZE IN SQUARE METERS/CULT1  PRIMARY
                CULTURAL AFFILIATION/CULT2  SECONDARY CULTURAL AFFILIATION/
                RELIEF  VERTICAL RELIEF WITHIN HALF-KILOMETER/DUNE  SITE ASSOC
                WITH DUNE/ELEV       FEET ABOVE SEA LEVEL/WATER  KILOMETERS TO
                PRIMARY WATER SOURCE/SOURCE  SOURCE OF PRIMARY WATER/
                WOOD  KILOMETERS TO JUNIPER AREA/SITEVEG  ON-SITE VEGETATION/
                AREAVEG  VEGETATION OF SURROUNDING AREA
MISSING VALUES  ALL(BLANK)
IF              (SITE EQ 952)VANTAGE =  0.45
IF              (SITE EQ 952)VIEW=320
IF              (SITE EQ 734)EXPOSURE=172
IF              (SITE EQ 755)EXPOSURE=167
IF              (SITE EQ 921)EXPOSUURE=98.45455
IF              (SITE EQ  743)EXPOSURE=172
IF              (PROJECT EQ 1 AND CATEGORY EQ 9)CLASS=0
IF              (PROJECT NE 1)CLASS=1
IF              (PROJECT EQ 1 AND CATEGORY EQ 0)CLASS=2
IF              (TYPE NE 2 OR 3)CAMP=0
IF              (TYPE EQ 2 OR 3)CAMP=1
RECODE          PROJECT(2 THRU 7 =0)
SELECT IF       (CULT1 NE 5)
RUN SUBFILES    ALL
DISCRIMINANT    GROUPS=CLASS(0.1)/VARIABLES=VANTAGE TO HEIGHT.RELIEF
                SHELTER.SLOPE.WOOD/ANALYSIS=VANTAGE TO WOOD/
                METHOD=RAO/VIN=2.7/FIN=2.7/FOUT=2.7
OPTIONS         5.6.7.8.11.12
STATISTICS      1.2.3.4.5.7.8
```

```
00103500 CM REQUIRED FOR DISCRIMINANT ANALYSIS
00103300 CM REQUIRED FOR DISCRIMINANT CLASSIFICATION

OPTION - 5
PRINT CLASSIFICATION RESULTS TABLE

OPTION - 6
PRINT DISCRIMINANT SCORES AND CLASSIFICATION INFORMATION

OPTION - 7
PRINT A SINGLE PLOT OF CASES

OPTION - 8
PRINT A SEPARATE PLOT FOR EACH GROUP

OPTION -11
PRINT UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

OPTION -12
PRINT CLASSIFICATION FUNCTIONS
```

FILE BONANZA (CREATION DATE = 80/10/30.) SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE MOONLAKE REDWASH MISC WHITE SEEP NONSITE

- D I S C R I M I N A N T A N A L Y S I S -

ON GROUPS DEFINED BY CLASS

200 (UNWEIGHTED) CASES WERE PROCESSED.
34 OF THESE WERE EXCLUDED FROM THE ANALYSIS.
34 HAD MISSING OR OUT-OF-RANGE GROUP CODES.
0 HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
0 HAD BOTH.
166 (UNWEIGHTED) CASES WILL BE USED IN THE ANALYSIS.

NUMBER OF CASES BY GROUP

CLASS	NUMBER OF CASES UNWEIGHTED	WEIGHTED	LABEL
0	68	68.0	
1	98	98.0	
TOTAL	166	166.0	

GROUP MEANS

CLASS	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
0	.97279	188.60294	84.67647	6.98971	31.10294	175.83824	1.25000	9.94118
1	.69347	218.16327	104.91837	11.07857	27.91837	134.44898	2.71429	6.64286
TOTAL	.80789	206.05422	96.62651	9.40361	29.22289	151.40361	2.11446	7.99398

CLASS	WOOD
0	8.73353
1	4.39867
TOTAL	6.17440

GROUP STANDARD DEVIATIONS

CLASS	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
0	.96343	89.32101	53.95865	5.26280	29.02451	133.78515	1.15092	13.16019
1	.60736	98.16719	48.44546	5.62103	33.42345	82.15376	3.36139	9.95169
TOTAL	.78279	95.48570	51.59145	5.82142	31.64297	107.94623	2.77524	11.45399

CLASS	WOOD
0	6.06215
1	2.96482
TOTAL	4.96608

POOLED WITHIN-GROUPS COVARIANCE MATRIX WITH 164 DEGREES OF FREEDOM

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.5973902							
VIEW	2.399634	8959.217						
EXPOSURE	2.393959	12.55836	2577.611					
RIVER	1.724630	-4.114848	-13.31218	30.00310				
HEIGHT	-9.316291	380.1530	28.74763	-34.64512	1004.900			
RELIEF	-41.71605	566.0088	675.4270	-270.9346	1575.029	11304.11		
SHELTER	-.2763436	-25.53463	6.111063	-1.057470	23.55466	69.36781	7.224085	
SLOPE	-2.616630	17.71418	47.81615	-24.27982	163.6253	581.3297	9.719512	129.3309
WOOD	-.9774404	23.55425	-5.799164	-7.168996	-5.363935	46.82139	-4.216080	6.730108

	WOOD
WOOD	20.21260

POOLED WITHIN-GROUPS CORRELATION MATRIX

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE	WOOD
VANTAGE	1.00000								
VIEW	.03280	1.00000							
EXPOSURE	.06101	.00261	1.00000						
RIVER	.40737	-.00794	-.04787	1.00000					
HEIGHT	-.38024	.12670	.01786	-.19953	1.00000				
RELIEF	-.50764	.05624	.12513	-.46523	.46731	1.00000			
SHELTER	-.13302	-.10037	.04478	-.07183	.27645	.24274	1.00000		
SLOPE	-.29769	.01646	.08282	-.38977	.45388	.48079	.31798	1.00000	
WOOD	-.28129	.05535	-.02541	-.29193	-.03764	.09795	-.34890	.13261	1.00000

CORRELATIONS WHICH CANNOT BE COMPUTED ARE PRINTED AS 99.0.

COVARIANCE MATRIX FOR GROUP 0.

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.9282025							
VIEW	.6226185	7978.243						
EXPOSURE	10.75137	702.4517	2911.536					
RIVER	2.377253	52.28391	40.51304	27.69706				
HEIGHT	-9.944919	484.3997	91.78007	-18.39892	842.4221			
RELIEF	-54.56581	1814.323	487.0961	-304.0121	1479.211	17898.47		
SHELTER	.1376866E-01	-14.86940	.8283582	1.998134	.6902985	-5.078358	1.324627	
SLOPE	-4.163863	29.24495	37.83143	-19.99912	230.1405	794.1993	-1.805970	173.1905
WOOD	-2.783134	73.58336	-29.11750	-18.23577	43.33187	263.1265	-1.725970	28.14335

	WOOD
WOOD	36.74961

COVARIANCE MATRIX FOR GROUP 1,

	VANTAGE	VIEW	EXPOSURE	RIVER	HEIGHT	RELIEF	SHELTER	SLOPE
VANTAGE	.3688909							
VIEW	3.627057	9636.798						
EXPOSURE	-3.378683	-463.9659	2346.962					
RIVER	1.273848	-43.07069	-50.49043	31.59593				
HEIGHT	-8.882085	308.1475	-14.79024	-45.86672	1117.127			
RELIEF	-32.84044	-296.2287	805.5113	-248.0872	1641.212	6749.240		
SHELTER	-.4767305	-32.90133	9.759941	-3.158041	39.34757	120.7894	11.29897	
SLOPE	-1.547923	9.749632	54.71281	-27.23660	117.6819	434.2960	-17.68041	99.03608
WOOD	.2697912	-11.00195	10.30731	.4412496	-38.99918	-102.5853	-5.936053	-7.975943

	WOOD
WOOD	8.790133

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FILE    BONANZA  (CREATION DATE =  80/10/30.)   SEEP RIDGE PROJECT REGIONAL ANALYSIS
SUBFILE   MOONLAKE   REDWASH   MISC      WHITE      SEEP       NONSITE

- - - - - - - - - - - - - - - - - - - - -   D I S C R I M I N A N T   A N A L Y S I S   - - - - - - - - - - - - - - - - - - - - -

ON GROUPS DEFINED BY CLASS


ANALYSIS NUMBER      1

STEPWISE VARIABLE SELECTION

     SELECTION RULE-  MAXIMIZE RAO*S V
     MAXIMUM NUMBER OF STEPS...................        18
     MINIMUM TOLERANCE LEVEL...................    .00100
     MINIMUM F TO ENTER........................    2.7000
     MAXIMUM F TO REMOVE.......................    2.7000
     MINIMUM INCREASE IN RAO*S V...............    2.7000

CANONICAL DISCRIMINANT FUNCTIONS

     MAXIMUM NUMBER OF FUNCTIONS...............         1
     MINIMUM CUMULATIVE PERCENT OF VARIANCE...    100.00
     MAXIMUM SIGNIFICANCE OF WILKS  LAMBDA....    1.0000

PRIOR PROBABILITY FOR EACH GROUP IS  .50000


-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   0 -------------
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VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VANTAGE	1.0000000	1.0000000	5.2431	5.24309
VIEW	1.0000000	1.0000000	3.9154	3.91539
EXPOSURE	1.0000000	1.0000000	6.3813	6.38134
RIVER	1.0000000	1.0000000	22.3700	22.37003
HEIGHT	1.0000000	1.0000000	.4051	
RELIEF	1.0000000	1.0000000	6.0837	6.08367
SHELTER	1.0000000	1.0000000	11.9150	11.91504
SLOPE	1.0000000	1.0000000	3.3768	3.37684
WOOD	1.0000000	1.0000000	37.3211	37.32106

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

AT STEP   1, WOOD      WAS INCLUDED IN THE ANALYSIS.

                                   DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA          .8146192     1     1      164.0
EQUIVALENT F           37.32106           1      164.0     .0000

RAO*S V                37.32106           1                .0000 (APPROX.)

--------------- VARIABLES IN THE ANALYSIS AFTER STEP   1 ---------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

WOOD       1.0000000    37.3211

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   1 --------------

                       MINIMUM
VARIABLE   TOLERANCE   TOLERANCE   F TO ENTER    RAO*S V

VANTAGE     .9208775    .9208775     14.1252     54.76703
VIEW        .9969363    .9969363      4.3595     42.70548
EXPOSURE    .9993545    .9993545      4.5542     42.94595
RIVER       .9147787    .9147787      7.6830     46.81036
HEIGHT      .9985835    .9985835       .6087
RELIEF      .9904053    .9904053      2.8529     40.84470
SHELTER     .8782658    .8782658      1.6071
SLOPE       .9824147    .9824147       .8701


F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   1
EACH F STATISTIC HAS   1 AND      164.0 DEGREES OF FREEDOM.

                GROUP        0

  GROUP

     1                    37.321
                           .0000
```

* *

AT STEP 2, VANTAGE WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.7496559	2	1	164.0		
EQUIVALENT F	27.21654		2	163.0	.0000	
RAO*S V	54.76703		2		.0000 (APPROX.)	

---------------- VARIABLES IN THE ANALYSIS AFTER STEP 2 ----------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
VANTAGE	.9208775	14.1252	
WOOD	.9208775	47.6971	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP 2 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VIEW	.9943956	.9167028	4.7569	61.19084
EXPOSURE	.9962043	.9179747	5.0457	61.58075
RIVER	.7999020	.7999020	17.6141	78.55333
HEIGHT	.8327178	.7679189	5.8622	62.68345
RELIEF	.7401180	.6881607	15.6720	75.93069
SHELTER	.8202367	.7689442	.0391	
SLOPE	.9087876	.8518623	3.3047	59.90494

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP 2
EACH F STATISTIC HAS 2 AND 163.0 DEGREES OF FREEDOM.

	GROUP 0
GROUP	
1	27.217 .0000

* *

AT STEP 3, RIVER WAS INCLUDED IN THE ANALYSIS.

		DEGREES OF FREEDOM			SIGNIF.	BETWEEN GROUPS
WILKS LAMBDA	.6761400	3	1	164.0		
EQUIVALENT F	25.86512		3	162.0	.0000	
RAO*S V	78.55333		3		.0000 (APPROX.)	

---------------- VARIABLES IN THE ANALYSIS AFTER STEP 3 ----------------

VARIABLE	TOLERANCE	F TO REMOVE	RAO*S V
VANTAGE	.8052349	24.3933	
RIVER	.7999020	17.6141	
WOOD	.8831706	27.1972	

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP 3 --------------

VARIABLE	TOLERANCE	MINIMUM TOLERANCE	F TO ENTER	RAO*S V
VIE	.9942974	.7998230	4.4290	85.22581
EXP[illegible]RE	.9893011	.7943591	6.0812	87.71488
HEI[illegible]	.8261511	.7001557	3.7914	84.26521
RELIEF	.6509520	.6509520	6.3802	88.16531
SHELTER	.8096472	.7282142	.5459	
SLOPE	.8248660	.7260354	.4502	

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP 3
EACH F STATISTIC HAS 3 AND 162.0 DEGREES OF FREEDOM.

GROUP	GROUP 0
1	25.865 .0000

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

AT STEP   4, RELIEF   WAS INCLUDED IN THE ANALYSIS.

                                     DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA           .6503670      4    1      164.0
EQUIVALENT F            21.63813           4      161.0   .0000

RAO*S V                 88.16531           4              .0000 (APPROX.)

--------------- VARIABLES IN THE ANALYSIS AFTER STEP   4 ---------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

VANTAGE     .6702944    31.3347
RIVER       .7035335     8.2098
RELIEF      .6509520     6.3802
WOOD        .8681337    29.6114

------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   4 -------------

                        MINIMUM
VARIABLE   TOLERANCE   TOLERANCE   F TO ENTER    RAO*S V

VIEW        .9860931    .6455808      5.2505     96.44032
EXPOSURE    .9629843    .6336358      8.1339    100.98463
HEIGHT      .7353998    .5794460      1.3231
SHELTER     .7853834    .6314441      1.3632
SLOPE       .7322445    .5778538       .0331

F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   4
EACH F STATISTIC HAS   4 AND      161.0 DEGREES OF FREEDOM.

                 GROUP        0

   GROUP

      1                     21.638
                             .0000
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AT STEP    5, EXPOSURE WAS INCLUDED IN THE ANALYSIS.

                                    DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA           .6189038     5     1      164.0
EQUIVALENT F            19.70432           5      160.0         0

RAO*S V                 100.9846           5                .0000 (APPROX.)

---------------- VARIABLES IN THE ANALYSIS AFTER STEP    5 ----------------


VARIABLE    TOLERANCE  F TO REMOVE      RAO*S V

VANTAGE      .6567064     34.4778
EXPOSURE     .9629843      8.1339
RIVER        .7031924      8.1119
RELIEF       .6336358      8.4348
WOOD         .8681204     27.6107


-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP    5 --------------

                         MINIMUM
VARIABLE    TOLERANCE   TOLERANCE   F TO ENTER     RAO*S V

VIEW         .9858799    .6282717      5.1498    109.56711
HEIGHT       .7351392    .5645858      1.1375
SHELTER      .7851300    .6157338      1.1789
SLOPE        .7314319    .5660121       .0072


F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP    5
EACH F STATISTIC HAS    5 AND      160.0 DEGREES OF FREEDOM.

                 GROUP         0

   GROUP

       1                  19.704
                               0
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AT STEP   6, VIEW      WAS INCLUDED IN THE ANALYSIS.

                                  DEGREES OF FREEDOM  SIGNIF.  BETWEEN GROUPS
WILKS  LAMBDA           .5994873   6    1      164.0
EQUIVALENT F           17.70444         6      159.0   .0000

RAO*S V                109.5671         6              .0000 (APPROX.)

---------------- VARIABLES IN THE ANALYSIS AFTER STEP   6 ----------------

VARIABLE   TOLERANCE  F TO REMOVE     RAO*S V

VANTAGE     .6519825    35.6426
VIEW        .9858799     5.1498
EXPOSURE    .9627762     8.0140
RIVER       .7028530     7.5008
RELIEF      .6282717     9.3447
WOOD        .8631807    28.4957

-------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   6 -------------

                       MINIMUM
VARIABLE   TOLERANCE  TOLERANCE   F TO ENTER    RAO*S V

HEIGHT      .7202930   .5636511     1.8955
SHELTER     .7780050   .6086881     1.6465
SLOPE       .7313789   .5614527      .0104


F STATISTICS AND SIGNIFICANCES BETWEEN PAIRS OF GROUPS AFTER STEP   6
EACH F STATISTIC HAS   6 AND      159.0 DEGREES OF FREEDOM.

                GROUP        0

  GROUP

     1                    17.704
                           .0000

F LEVEL OR TOLERANCE OR VIN INSUFFICIENT FOR FURTHER COMPUTATION.
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SUMMARY TABLE

STEP	ACTION ENTERED	ACTION REMOVED	VARS IN	WILKS LAMBDA	SIG.	RAO*S V	SIG.	CHANGE IN V	SIG.	LABEL
1	WOOD		1	.814619	.0000	37.3211	.0000	37 3211	.0000	KILOMETERS TO JUNIPER AREA
2	VANTAGE		2	.749656	.0000	54.7670	.0000	17.4460	.0000	KILOMETERS TO VANTAGE
3	RIVER		3	.676140	.0000	78.5533	.0000	23.7863	.0000	KILOMETERS TO WHITE OR GREEN RIVERS
4	RELIEF		4	.650367	.0000	88.1653	.0000	9.6120	.0019	VERTICAL RELIEF WITHIN HALF-KILOMETER
5	EXPOSURE		5	.618904	0	100.9846	.0000	12.8193	.0003	0 TO 180 DEGREES EXPOSURE
6	VIEW		6	.599487	.0000	109.5671	.0000	8.5825	.0034	DEGREES OF VIEWSPREAD

CLASSIFICATION FUNCTION COEFFICIENTS
(FISHER*S LINEAR DISCRIMINANT FUNCTIONS)

CLASS =	0	1
VANTAGE	3.623464	1.833530
VIEW	.1613532E-01	.2105511E-01
EXPOSURE	.2415747E-01	.3563622E-01
RIVER	.5364264	.6570822
RELIEF	.3662761E-01	.2932951E-01
WOOD	.7013791	.4577379
(CONSTANT)	-13.15772	-12.11322

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	PERCENT OF VARIANCE	CUMULATIVE PERCENT	CANONICAL CORRELATION	-- AFTER FUNCTION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIGNICANCE
					- 0	.5994873	82.381	6	.0000
1*	.66309	100.00	100.00	.6328602	-				

* MARKS THE 1 FUNCTION(S) TO BE USED IN THE REMAINING ANALYSIS.

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
VANTAGE	-.83741
VIEW	.28187
EXPOSURE	.35276
RIVER	.40004
RELIEF	-.46968
WOOD	-.66303

UNSTANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
VANTAGE	-1.083454
VIEW	.2977963E-02
EXPOSURE	.6948130E-02
RIVER	.7303340E-01
RELIEF	-.4417567E-02
WOOD	-.1474769
(CONSTANT)	.4829569

CANONICAL DISCRIMINANT FUNCTIONS EVALUATED AT GROUP MEANS (GROUP CENTROIDS)

GROUP	FUNC 1
0	-.97531
1	.67675

TEST OF EQUALITY OF GROUP COVARIANCE MATRICES USING BOX*S M

THE RANKS AND NATURAL LOGARITHMS OF DETERMINANTS PRINTED ARE THOSE OF THE GROUP COVARIANCE MATRICES.

GROUP LABEL	RANK	LOG DETERMINANT
0	6	32.366141
1	6	29.057787
POOLED WITHIN-GROUPS COVARIANCE MATRIX	6	31.393448

BOX*S M	APPROXIMATE F	DEGREES OF FREEDOM		SIGNIFICANCE
161.39	7.3714	21.	76339.1	.0000

CASE SUBFILE	CASE SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
MOONLAKE	1			1.		1	.7425	.6946	0	.3054	.3482
MOONLAKE	2			1.		1	.5568	.9118	0	.0882	1.2644
MOONLAKE	3			1.		1	.5994	.6217	0	.3783	.1515
MOONLAKE	4			1.		1	.4733	.9264	0	.0736	1.3842
MOONLAKE	5			1.		1	.8291	.7326	0	.2674	.4609
MOONLAKE	6			1.		1	.8968	.8290	0	.1710	.8064
MOONLAKE	7			1.		1	.7428	.6948	0	.3052	.3486
MOONLAKE	8			1.		1	.6915	.8829	0	.1171	1.0735
MOONLAKE	9			1.		1	.5434	.5892	0	.4108	.0690
MOONLAKE	11			1.		1	.9723	.8057	0	.1943	.7115
MOONLAKE	12			1.		1	.7277	.6877	0	.3123	.3285
MOONLAKE	13			1.		1	.4836	.9257	0	.0743	1.3772
MOONLAKE	14			1.		1	.6715	.8875	0	.1125	1.1008
MOONLAKE	15			1.		1	.4863	.9252	0	.0748	1.3730
MOONLAKE	16			1.		1	.8382	.8458	0	.1542	.8810
MOONLAKE	17			1.		1	.8465	.8435	0	.1565	.8704
MOONLAKE	18			1.		1	.4468	.9322	0	.0678	1.4375
MOONLAKE	20			1.		1	.5956	.6196	0	.3804	.1460
MOONLAKE	21			1.	***	0	.6442	.6460	1	.3540	-.5134
MOONLAKE	22			1.		1	.9031	.8272	0	.1728	.7985
MOONLAKE	23			1.		1	.3985	.9404	0	.0596	1.5210
MOONLAKE	24			1.		1	.3435	.9493	0	.0507	1.6239
MOONLAKE	25			1.	***	0	.8949	.7589	1	.2411	-.8432
MOONLAKE	26			1.		1	.6291	.8968	0	.1032	1.1598
MOONLAKE	27			1.		1	.4520	.5305	0	.4695	-.0753
MOONLAKE	28			1.		1	.7500	.8689	0	.1311	.9954
MOONLAKE	29			1.		1	.5933	.6183	0	.3817	.1426
MOONLAKE	30			1.		1	.9090	.8254	0	.1746	.7911
MOONLAKE	31			1.		1	.6193	.6327	0	.3673	.1799
MOONLAKE	32			1.		1	.4813	.5502	0	.4498	-.0274
MOONLAKE	33			1.		1	.8065	.8538	0	.1462	.9191
MOONLAKE	34			1.		1	.7153	.6818	0	.3182	.3120
MOONLAKE	35			1.		1	.6687	.8835	0	.1165	1.0773
MOONLAKE	36			1.		1	.9938	.7986	0	.2014	.6845
MOONLAKE	37			1.		1	.9029	.7619	0	.2381	.5548
MOONLAKE	38			1.		1	.9419	.7763	0	.2237	.6039
MOONLAKE	39			1.	***	0	.6366	.6431	1	.3569	-.5056
MOONLAKE	40			1.		1	.2961	.9565	0	.0435	1.7217
MOONLAKE	41			1.	***	0	.5719	.6061	1	.3939	-.4101
MOONLAKE	42			1.		1	.6243	.6354	0	.3646	.1869
MOONLAKE	43			1.	***	0	.7534	.6997	1	.3003	-.6612
MOONLAKE	44			1.		1	.4992	.5618	0	.4382	.0010
MOONLAKE	45			1.		1	.4617	.9296	0	.0704	1.4127
MOONLAKE	46			1.		1	.8216	.7295	0	.2705	.4512
MOONLAKE	47			1.		1	.4219	.5095	0	.4905	-.1264
MOONLAKE	48			1.	***	0	.6686	.6587	1	.3413	-.5472
MOONLAKE	50			1.		1	.5905	.9050	0	.0950	1.2148
MOONLAKE	51			1.		1	.7656	.8650	0	.1350	.9749
MOONLAKE	52			1.		1	.9786	.7892	0	.2108	.6499
MOONLAKE	53			1.		1	.5385	.9154	0	.0846	1.2919
MOONLAKE	54			1.		1	.0681	.9876	0	.0124	2.5014
MOONLAKE	55			1.		1	.9162	.8232	0	.1768	.7820

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST GROUP	PROBABILITY P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
REDWASH	1			1.		1	.2665	.9609	0	.0391	1.7880
REDWASH	2			1.	***	0	.6572	.6528	1	.3472	-.5316
REDWASH	3			1.		1	.5835	.6128	0	.3872	.1285
REDWASH	4			1.		1	.154B	.9762	0	.0238	2.0994
REDWASH	6			1.	***	0	.7B36	.7132	1	.2868	-.7007
REDWASH	7			1.		1	.3416	.9496	0	.0504	1.6277
REDWASH	8			1.		1	.630B	.63B9	0	.3611	.1961
REDWASH	9			1.		1	.7829	.7129	0	.2871	.4012
REDWASH	10			1.		1	.4108	.93B4	0	.0616	1.4993
REDWASH	11			1.		1	.6189	.8990	0	.1010	1.1741
REDWASH	12			1.		1	.B601	.8397	0	.1603	.8530
REDWASH	13			1.		1	.6051	.9019	0	.0981	1.1939
REDWASH	14			1.	***	0	.6474	.6477	1	.3523	-.51B0
REDWASH	15			1.		1	.1613	.9754	0	.0246	2.0774
REDWASH	16			1.		1	.3913	.9416	0	.0584	1.5339
REDWASH	17			1.		1	.0345	.9923	0	.0077	2.7910
REDWASH	18			1.		1	.297B	.9563	0	.0437	1.7178
REDWASH	19			1.		1	.6176	.6318	0	.3682	.1775
REDWASH	20			1.		1	.B569	.7440	0	.2560	.4964
REDWASH	21			1.		1	.5256	.57B4	0	.4216	.0420
REDWASH	22			1.	***	0	.5483	.5922	1	.4078	-.3751
REDWASH	23			1.		1	.1414	.9780	0	.0220	2.1475
REDWASH	24			1.		1	.4544	.5321	0	.4679	-.0713
REDWASH	25			1.		1	.B659	.7476	0	.2524	.5079
REDWASH	26			1.		1	.1474	.9772	0	.0228	2.1256
MISC	1			1.		1	.6843	.6666	0	.3334	.2701
MISC	2			1.	***	0	.4291	.5146	1	.4854	-.1846
MISC	3			1.		1	.6291	.6380	0	.3620	.1938
MISC	4			1.		1	.6993	.6740	0	.3260	.2905
MISC	5			1.		1	.8102	.7247	0	.2753	.4366
MISC	6			1.		1	.5703	.9091	0	.0909	1.2444
MISC	7			1.		1	.3238	.9523	0	.0477	1.6633
MISC	9			1.		1	.9637	.8084	0	.1916	.7223
MISC	10			1.		1	.4817	.9260	0	.0740	1.3803
WHITE	1			1.		1	.7845	.7136	0	.2864	.4033
WHITE	2			1.		1	.5203	.5751	0	.4249	.0339
WHITE	3			1.		1	.4451	.5258	0	.4742	-.086B
WHITE	4			1.		1	.9854	.8014	0	.1986	.6951
WHITE	5			1.	***	0	.4877	.5543	1	.4457	-.2813
WHITE	6			1.		1	.71B2	.6832	0	.3168	.3159
WHITE	7			1.		1	.962B	.7837	0	.2163	.6301
WHITE	8			1.		1	.9086	.7640	0	.2360	.5620
WHITE	9			1.		1	.9429	.7767	0	.2233	.6051
WHITE	10			1.		1	.4198	.5080	0	.4920	-.1300
WHITE	11			1.		1	.774B	.7093	0	.2907	.3907
SEEP	4			UNGRPD		1	.11BB	.9810	0	.0190	2.2367
SEEP	5			UNGRPD		0	.4246	.5113	1	.48B7	-.176B
SEEP	6			UNGRPD		1	.5257	.5784	0	.4216	.0421
SEEP	7			UNGRPD		0	.4427	.5241	1	.4759	-.2077
SEEP	8			UNGRPD		1	.5752	.9081	0	.0919	1.2372
SEEP	10			UNGRPD		0	.9548	.8113	1	.18B7	-1.0320
SEEP	11			UNGRPD		1	.4094	.9386	0	.0614	1.5017
SEEP	12			UNGRPD		1	.5818	.9067	0	.0933	1.2275

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
SEEP	13			UNGRPD		1	.8748	.8355	0	.1645	.8343
SEEP	15			UNGRPD		1	.8182	.8513	0	.1487	.9067
SEEP	16			UNGRPD		1	.0201	.9945	0	.0055	3.0012
SEEP	17			UNGRPD		1	.4351	.9343	0	.0657	1.4572
SEEP	18			UNGRPD		1	.7499	.6980	0	.3020	.3580
SEEP	19			UNGRPD		1	.8296	.7328	0	.2672	.4615
SEEP	20			UNGRPD		1	.7987	.7198	0	.2802	.4217
SEEP	21			UNGRPD		1	.8381	.8458	0	.1542	.8811
SEEP	22			UNGRPD		1	.6423	.8940	0	.1060	1.1412
SEEP	23			UNGRPD		1	.3940	.9412	0	.0588	1.5291
SEEP	24			UNGRPD		1	.4889	.9247	0	.0753	1.3688
SEEP	25			UNGRPD		1	.3378	.9502	0	.0498	1.6352
SEEP	26			UNGRPD		1	.0601	.9887	0	.0113	2.5571
SEEP	27			UNGRPD		1	.1169	.9812	0	.0188	2.2446
SEEP	28			UNGRPD		1	.0688	.9875	0	.0125	2.4963
SEEP	29			UNGRPD		1	.2079	.9691	0	.0309	1.9363
SEEP	30			UNGRPD		1	.1016	.9832	0	.0168	2.3140
SEEP	31			UNGRPD		1	.5449	.9141	0	.0859	1.2822
SEEP	32			UNGRPD		1	.2932	.9569	0	.0431	1.7278
SEEP	33			UNGRPD		1	.2282	.9663	0	.0337	1.8817
SEEP	34			UNGRPD		1	.3443	.9492	0	.0508	1.6225
SEEP	35			UNGRPD		1	.7359	.8723	0	.1277	1.0140
SEEP	36			UNGRPD		1	.1480	.9771	0	.0229	2.1235
SEEP	38			UNGRPD		1	.2876	.9578	0	.0422	1.7401
SEEP	39			UNGRPD		1	.3187	.9531	0	.0469	1.6739
SEEP	40			UNGRPD		1	.5340	.9162	0	.0838	1.2986
NONSITE	1			0	***	1	.2960	.9565	0	.0435	1.7218
NONSITE	2			0		0	.1666	.9747	1	.0253	-2.3585
NONSITE	3			0		0	.1217	.9806	1	.0194	-2.5230
NONSITE	4			0		0	.1493	.9769	1	.0231	-2.4172
NONSITE	5			0		0	.8551	.8411	1	.1589	-1.1579
NONSITE	6			0		0	.2095	.9689	1	.0311	-2.2302
NONSITE	7			0		0	.9451	.8140	1	.1860	-1.0430
NONSITE	8			0		0	.3887	.9421	1	.0579	-1.8374
NONSITE	9			0		0	.0867	.9852	1	.0148	-2.6885
NONSITE	10			0		0	.0030	.9981	1	.0019	-3.9395
NONSITE	11			0		0	.0017	.9986	1	.0014	-4.1143
NONSITE	12			0		0	.3230	.9525	1	.0475	-1.9636
NONSITE	13			0		0	.7761	.7099	1	.2901	-.6909
NONSITE	14			0		0	.4740	.5453	1	.4547	-.2593
NONSITE	15			0		0	.7032	.8802	1	.1198	-1.3564
NONSITE	16			0		0	.1216	.9806	1	.0194	-2.5234
NONSITE	17			0		0	.1522	.9766	1	.0234	-2.4072
NONSITE	18			0		0	.4703	.5429	1	.4571	-.2533
NONSITE	19			0		0	.0674	.9877	1	.0123	-2.8041
NONSITE	20			0		0	.9095	.7644	1	.2356	-.8617
NONSITE	21			0	***	1	.5013	.5631	0	.4369	.0044
NONSITE	22			0		0	.8738	.7507	1	.2493	-.8164
NONSITE	23			0		0	.1514	.9767	1	.0233	-2.4098
NONSITE	24			0	***	1	.9221	.7691	0	.2309	.5790
NONSITE	25			0		0	.4437	.5248	1	.4752	-.2093
NONSITE	26			0		0	.7267	.6872	1	.3128	-.6256

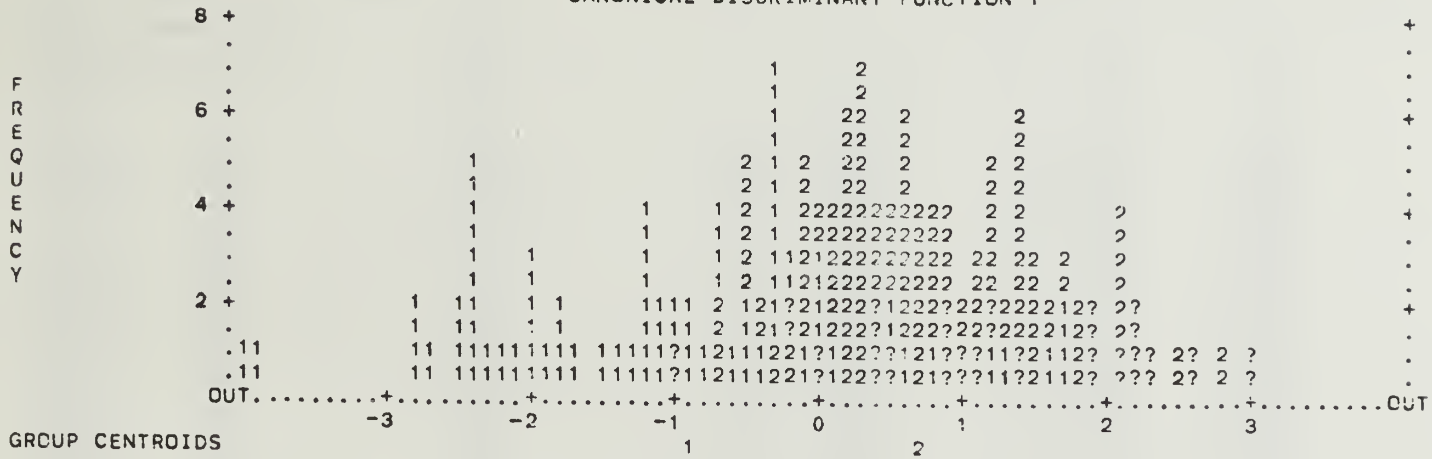
CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP		HIGHEST GROUP	PROBABILITY P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
NONSITE	28			0		0	.5206	.5753	1	.4247	-.3329
NONSITE	29			0	***	1	.8878	.7561	0	.2439	.5357
NONSITE	30			0		0	.4953	.5592	1	.4408	-.2934
NONSITE	31			0		0	.8095	.7244	1	.2756	-.7343
NONSITE	32			0		0	.9199	.8221	1	.1779	-1.0759
NONSITE	33			0	***	1	.6357	.8954	0	.1046	1.1505
NONSITE	34			0		0	.6212	.6338	1	.3662	-.4812
NONSITE	35			0		0	.4161	.5053	1	.4947	-.1621
NONSITE	36			0		0	.2876	.9578	1	.0422	-2.0386
NONSITE	37			0		0	.2871	.9578	1	.0422	-2.0397
NONSITE	38			0		0	.4964	.9233	1	.0767	-1.6556
NONSITE	39			0		0	.0681	.9876	1	.0124	-2.7997
NONSITE	40			0		0	.4701	.5427	1	.4573	-.2530
NONSITE	41			0		0	.9707	.7865	1	.2135	-.9386
NONSITE	42			0		0	.5859	.6141	1	.3859	-.4305
NONSITE	43			0	***	1	.4194	.5077	0	.4923	-.1307
NONSITE	44			0		0	.4361	.9341	1	.0659	-1.7541
NONSITE	45			0		0	.9567	.8107	1	.1893	-1.0296
NONSITE	46			0		0	.4718	.5439	1	.4561	-.2558
NONSITE	47			0		0	.5666	.9098	1	.0902	-1.5484
NONSITE	48			0		0	.6505	.6494	1	.3506	-.5223
NONSITE	49			0		0	.3749	.9443	1	.0557	-1.8626
NONSITE	50			0	***	1	.5163	.5726	0	.4274	.0277
NONSITE	51			0	***	1	.4959	.5596	0	.4404	-.0042
NONSITE	52			0		0	.9363	.8171	1	.1829	-1.0553
NONSITE	53			0		0	.7117	.8782	1	.1218	-1.3449
NONSITE	54			0		0	.1653	.9748	1	.0252	-2.3627
NONSITE	55			0		0	.7740	.7090	1	.2910	-.6882
NONSITE	56			0		0	.2632	.9613	1	.0387	-2.0941
NONSITE	57			0		0	.7657	.7052	1	.2948	-.6773
NONSITE	58			0	***	1	.3281	.9517	0	.0483	1.6548
NONSITE	59			0	***	1	.3328	.9510	0	.0490	1.6453
NONSITE	60			0		0	.5185	.5740	1	.4260	-.3297
NONSITE	61			0		0	.1957	.9707	1	.0293	-2.2691
NONSITE	62			0		0	.8339	.8470	1	.1530	-1.1850
NONSITE	63			0	***	1	.9077	.8258	0	.1742	.7927
NONSITE	64			0	***	1	.5904	.6167	0	.3833	.1385
NONSITE	65			0	***	1	.5484	.9134	0	.0866	1.2768
NONSITE	66			0		0	.8562	.8408	1	.1592	-1.1565
NONSITE	67			0	***	1	.8663	.7477	0	.2523	.5084
NONSITE	68			0		0	.8248	.8495	1	.1505	-1.1967

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	0	
2	1	
"		ALL UNGROUPED CASES

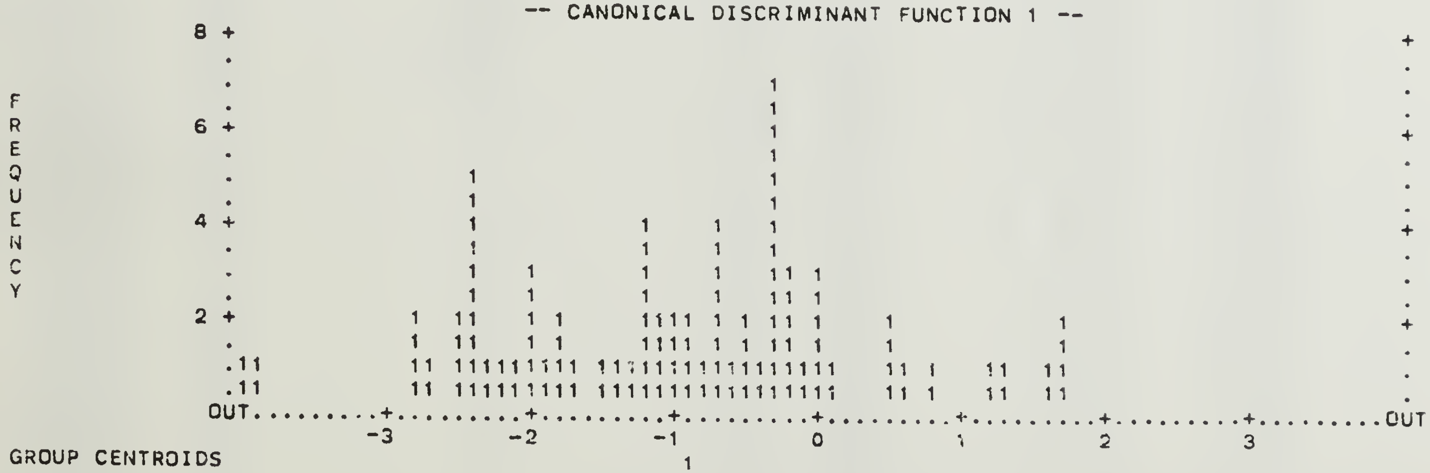
ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --



HISTOGRAM FOR GROUP 0

-- CANONICAL DISCRIMINANT FUNCTION 1 --



HISTOGRAM FOR GROUP   1

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
       8 +                                                                                 +
         .                                                                                 .
         .                                           2                                     .
F        .                                           2                                     .
R      6 +                                          22  2       2                          +
E        .                                          22  2       2                          .
Q        .                                   2   2  22  2     2 2                          .
U        .                                   2   2  22  2     2 2                          .
E      4 +                                   2   22222222222  2 2      2                   +
N        .                                   2   22222222222  2 2      2                   .
C        .                                   2   22222222222 22 22 2   2                   .
Y        .                                   2   22222222222 22 22 2   2                   .
       2 +                                 2 22  22222222222222222222  2                   +
         .                                 2 22  22222222222222222222  2                   .
         .                                22 222222222222222222222222  2   2  2            .
         .                                22 222222222222222222222222  2   2  2            .
        OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                   -3        -2        -1         0         1         2         3
GROUP CENTROIDS
                                                         2
```

HISTOGRAM FOR UNGROUPED CASES

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
       4 +                                                                                 +
         .                                                                                 .
         .                                                                                 .
F        .                                                                                 .
R      3 +                                                       ? ?                       +
E        .                                                       ? ?                       .
Q        .                                                       ? ?                       .
U        .                                                       ? ?                       .
E      2 +                                      ?     ?    ?  ?? ??? ?  ?                  +
N        .                                      ?     ?    ?  ?? ??? ?  ?                  .
C        .                                      ?     ?    ?  ?? ??? ?  ?                  .
Y        .                                      ?     ?    ?  ?? ??? ?  ?                  .
       1 +                              ?       ? ?   ??  ?????????? ? ??? ??   ?          +
         .                              ?       ? ?   ??  ?????????? ? ??? ??   ?          .
         .                              ?       ? ?   ??  ?????????? ? ??? ??   ?          .
         .                              ?       ? ?   ??  ?????????? ? ??? ??   ?          .
        OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                   -3        -2        -1         0         1         2         3
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP 0	1
GROUP 0	68	54 79.4	14 20.6
GROUP 1	98	12 12.2	86 87.8
UNGROUPED CASES	34	3 8.8	31 91.2

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 84.34

CLASSIFICATION PROCESSING SUMMARY

200 CASES WERE PROCESSED.
0 CASES HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
200 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. 7.9160 SECONDS

RUN SUBFILES (MOONLAKE.REDWASH.MISC.WHITE.SEEP)
NPAR TESTS K-S=VANTAGE TO EXPOSURE BY PROJECT(0.1)/K-S=VANTAGE TO HEIGHT
RELIEF SHELTER TO WATER WOOD BY CAMP(0.1)

GIVEN 13 VARIABLES, INITIAL CM ALLOWS FOR 122 CASES
MAXIMUM CM ALLOWS FOR 1678 CASES

APPENDIX 12

Example of the application of the predictive model of site location

The purpose of this appendix is to illustrate the application of the predictive model of site location developed for the Seep Ridge data, and to provide step-by-step procedures for its implementation. The discriminant function which uses only variables which can be measured from USGS topographic maps, as discussed in the text, will be applied in the examples below. This particular equation would be the most useful for determining the probability of site occurrence at loci which have not been field inspected.

The equation requires that six topographic variables first be measured for each locus: viewspread, distance to a vantage point, rescaled exposure, distance to a major river, vertical relief within a 500 meter radius, and distance to a juniper zone. Figure 1 shows the locations of two prehistoric sites and three nonsite points. The values measured from this and adjoining maps for each of the six discriminant variables are presented in Table 1, below.

TABLE 1. Measurements of six topographic discriminant variables.

Locus/ Variable	VIEW	VANTAGE (km)	EXPOSURE	RIVER (km)	RELIEF (feet)	WOOD (km)
Site 42Un920	180	0.05	180	5.6	127	15.4
Site 42Un921	340	0	98	5.7	160	15.8
Nonsite 418	270	0.9	10	4.4	120	13.8
Nonsite 489	305	0.28	40	4.6	120	15.1
Nonsite 538	240	0.48	102	4.2	120	16.0

In order to determine the probability that any of the above locales contains a site, it is first necessary to calculate the discriminant score (D_i) by using the following equation:

$$\begin{aligned} D_i = {} & .00298(\text{viewspread}) - 1.08345(\text{distance to vantage}) \\ & + .00695(\text{exposure}) + .07303(\text{distance to river}) \\ & - .00442(\text{vertical relief}) - .14748\ (\text{distance to} \\ & \text{juniper}) + .48296. \end{aligned}$$

This is accomplished by multiplying the value of each variable by its weighting coefficient, as given in the above equation, and adding the constant value 0.48296 to the sum of the products. For example, the discriminant score of -0.207 for site 42Un920 would be calculated as

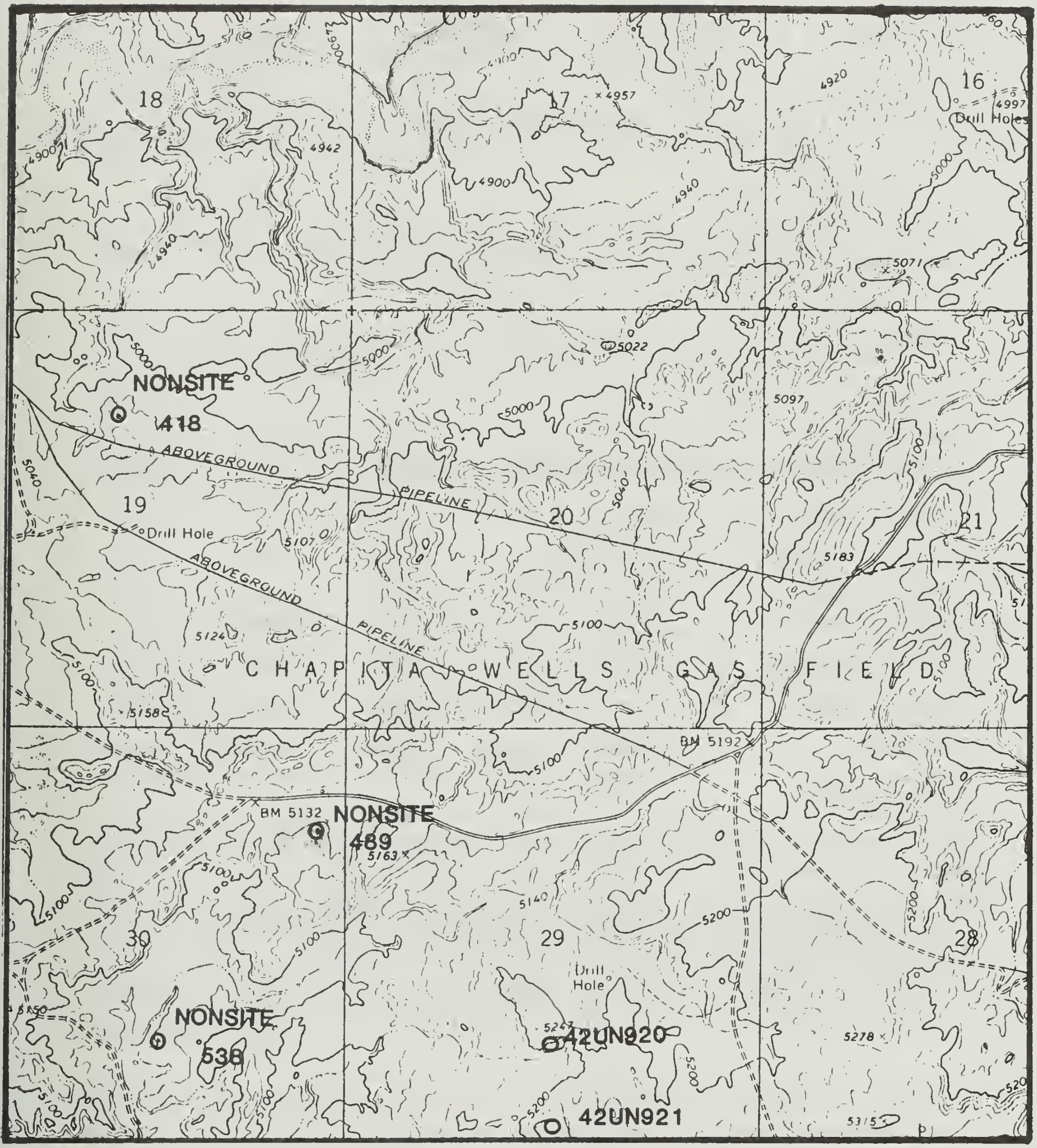


Figure 1. Map showing locations of sites and "nonsites".
U.S.G.S. 7.5 min. map: Red Wash SE, Utah (1968).
Township 9 South, Range 23 East.

follows: D_i = (.00298)(180) - (1.08345)(0.05) + (.00695)(180) + (.07303)(5.6) - (.00442)(127) - (.14748)(15.4) + .48296

D_i = .5364 - .0542 + 1.251 + .409 - .5613 - 2.271 + .48296

D_i = -0.207

Table 2 shows the results of the application of this equation for the two sites and three nonsites in our example.

TABLE 2. Results of the application of the discriminant equation.

Variable / Locus (weighting coefficient)	42Un920	42Un921	Nonsite 418	Nonsite 489	Nonsite 538
VIEW(.00298)	.5364	1.0132	.8046	.9089	.7152
VANTAGE(-1.08345)	-.0542	0	-.9751	-.3034	-.5201
EXPOSURE(.00695)	1.251	.6811	.0695	.278	.7089
RIVER(.07303)	.409	.4163	.3213	.3359	.3067
RELIEF(-.00442)	-.5613	-.7072	-.5304	-.5304	-.5304
WOOD(-.14748)	-.2.271	-2.3302	-2.0352	-2.2269	-2.3597
CONSTANT	.48296	.48296	.48296	.48296	.48296
DISCRIMINANT SCORE (D_i)	-.207	-.4438	-1.8623	-1.0549	-1.1964

The final step is the use of the discriminant score to calculate the probability that the locus in question contains a site. The following equation is used:

$$p(s/d) = e^{(-0.5 \times (d_i - 0.67675)^2)} \Big/ \left(e^{(-0.5 \times (d_i - 0.67675)^2)} + e^{(-0.5 \times (d_i - (-0.97531))^2)}\right)$$

where d_i is the discriminant score and e is the natural logarithm of the computed numbers. This can be accomplished by the following steps:

Step 1:	Subtract 0.67675 from D_i	-.207 - .67675
Step 2:	Square the difference	$(-.88375)^2$
Step 3:	Multiply result by -0.5	(-0.5)(.781)
Step 4:	Take natural log of result	$e^{(-.3905)}$

Step 5:	Store this result	0.6767
Step 6:	Add 0.97531 to D_i	-.207 - (-.97531)
Step 7:	Square the sum	$(.76831)^2$
Step 8:	Multiply result by -0.5	(-0.5)(.5903)
Step 9:	Take natural log of result	$e^{(-.2952)}$
Step 10:	Add results of steps 4 and 9	.6767 + .7444
Step 11:	Divide step 4 by sum of step 10	.6767 ÷ 1.421
ANSWER is probability that locus is a site		.4762

When probabilities are calculated for each of the points in our example, the following results are obtained:

	p(s/d)	percent probability
Site 42Un920	.4762	48%
Site 42Un921	.3807	38%
Nonsite 418	.0557	6%
Nonsite 489	.183	18%
Nonsite 538	.1506	15%

As a final note, the fact that each of the five loci have less than a 50% probability of containing a site -- when, in fact, two of the points are sites -- points out the necessity of further refining the predictive model of site location before it can be used with any confidence as a management tool. Nonetheless, the probability that the two "misclassified" site loci are indeed sites (had we not known of their presence) is considerably greater than the probability that the nonsite loci represented site locales.

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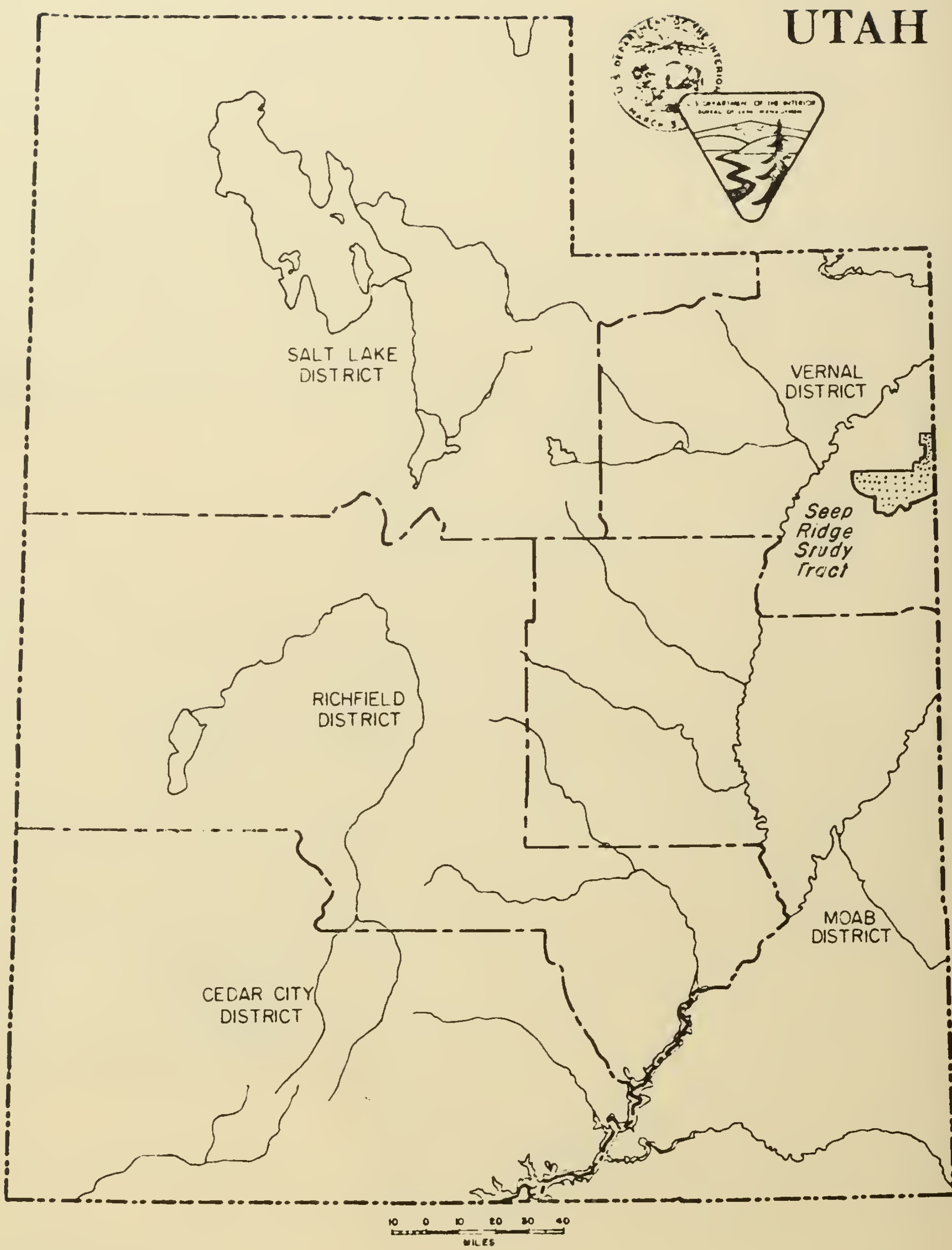
UTAH
SALT LAKE DISTRICT
VERNAL DISTRICT
Seep Ridge Study Tract
RICHFIELD DISTRICT
CEDAR CITY DISTRICT
MOAB DISTRICT
10 0 10 20 30 40
MILES